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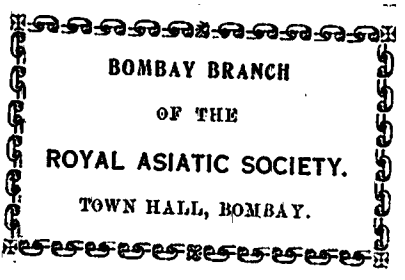

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ANNUAL REPORT

OF THE

IMPERIAL DEPARTMENT OF AGRICULTURE 1904-05 & 19

(and Subsequent Reports "Progress of Agriculture")

FOR THE YEAR

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1904-05. to 1915-16

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TABLE OF CONTENTS.

Page.

Preface v

PART I.—*Report of the Officiating Inspector-General,* by Mr. F. G. Sly, I.C.S. . . . . 1—39

Paragraph.

1. Duties of the Inspector-General 1
2. Staff 1
3. Tours 2
4. Board of Agriculture 3
5. The Agricultural Research Institute, Pusa 3
6. Agricultural Chemistry 5
7. „ „ Saltpetre as manure 7
8. „ „ Mineral Fertilizers 9
9. Mycology 10
10. „ Wheat Rusts 12
11. „ Ground-nut leaf disease 13
12. Entomology 13
13. „ The Bombay Locust 14
14. „ Grasshoppers 15
15. Cotton. Survey of indigenous varieties 15
16. „ Selection of Seed 17
17. „ Hybridization 17
18. „ Trial of Exotics 18
19. „ Tree Cottons 19
20. „ Improvement of methods of cultivation . . . 20
21. „ Extension of cotton cultivation 20
22. „ Future expansion of cotton investigation . . . 21
23. Cotton seed oil industry 21
24. Tea 22
25. Indigo 24
26. Jute 24
27. Juar 26
28. Maize 26
29. Soy Beans 26
30. Tobacco 27
31. Sweet Potatoes 27
32. Irrigation 27
33. Sericulture 28
34. Agricultural Education 29
35. Distribution of seeds and implements 30

PART I.—*Report of the Officiating Inspector-General*, by Mr. F. G Sly, I.C.S.—*contd.*

Paragraph.		Page.
36.	Publications	32
37.	Expenditure	32
38.	Provincial Departments, Bombay	33
39.	„ „ Madras	34
40.	„ „ United Provinces	34
41.	„ „ Bengal	35
42.	„ „ Punjab	36
43.	„ „ Central Provinces	36
44.	„ „ Assam	36
45.	„ „ Burma	37
46.	„ „ Native States	37
47.	Proposals for future expansion	38

PART II.—*Report of the Agricultural Research Institute, Pusa*, by Mr. B. Coventry, Director. 41—49

1—2.	General History	41
3.	Objects and aims	42
4.	Board of Agriculture	43
5.	General features of year's work	43
6.	Buildings and other works. Public Works Department	43
7—8.	„ „ „ „ Departmental work	44
9.	The Farm. Cultivation	44
10.	„ „ Cotton experiments	45
11—13.	„ „ Cattle Farm	46
14.	Chemistry	47
15.	Botany	47
16.	Entomology	47
17.	Mycology	48
18.	Bacteriology	48
19.	Weather	48
20.	Accounts	49

PART III.—*Report of the Agricultural Chemist to the Government of India*, by Dr. J. W. Leather, Ph.D., F.I.C., etc. 51—70

1—2.	Prefatory	51
3.	Tours	51
4—5.	Analysis of agricultural materials	52
6.	„ of soils	53
7.	Sampling soils	53
8.	Available plant food in soils	53
9—10.	*Usar* or Saline soils	54
11—13.	Combined Nitrogen in Rain and Dew	55
14—15.	Drainage water at Cawnpore	57

PART III.—*Report of the Agricultural Chemist to the Government of India*, by Dr. J. W. Leather, Ph.D., F.I.C., etc.—*contd.*

Paragraph.		Page
16.	Well waters	5
17.	Manures	5
18—21.	Sewage	5
22.	Canal silt and waters	6
23—24.	Saltpetre	6
25.	Food grains and fodders	6
26.	Oil seeds	6
27—28.	Poisonous plants	6
29—33.	Sugar	60
34.	Dairy produce—Milk	68
35.	Analyses of Forest products	69
36—37.	Lectures	69
38.	Publications	69
39—41.	Establishment	69

PART IV.—*Report of the Cryptogamic Botanist to the Government of India*, by Dr. E. J. Butler, M.B., F.L.S. . . 71—88

1—3.	Prefatory	71
4.	Establishment	72
5—8.	Touring	72
9.	Provincial work in fungus diseases	73
10.	Epidemics of fungus diseases	74
11.	Treatment of fungus diseases	75
12.	Potato diseases	76
13—14.	Wheat rusts	76
15.	Other rusts	78
16—20.	Sugarcane diseases	79
21.	Spike disease of sandal	81
22.	Tea and Coffee diseases	81
23.	Tur wilt	82
24—25.	Pepper diseases	83
26.	Other wilt diseases	83
27.	Ground-nut leaf disease	83
28.	Oat smut	84
29.	Other smuts	84
30.	Sorghum diseases	84
31.	Green-ear disease of the bulrush millet	85
32.	Diseases of trees	85
33.	Vine diseases	86
34—35.	Betel palm diseases	86
36.	Kodra poisoning	86
37.	Mychoriza	86
38.	Nodule bacilli of Leguminosæ	87

PART IV.—*Report of the Cryptogamic Botanist to the Government of India*, by Dr. E. J. Butler, M.B., F.L.S.—*contd.*

Paragraph. Page.

39. Miscellaneous 87
40. Publications 88

PART V.—*Report of the Entomologist to the Government of India*, by Mr. H. M. Lefroy, M.A., F.E.S., F.Z.S. . . 89—98

1—3. Historical 89
4. Investigation of crop pests 90
5. Special inquiries 91
6. Remedies 91
7. Beneficial insects 93
8. Collections 93
9. Indian Museum 94
10. Work at Pusa 94
11. Field study of insect pests 95
12. Publications 96
13. Rural Education 96
14. Future needs 97

APPENDIX A.—An account of the scientific investigations of Indigo which have been and are being conducted in India, by Mr. C. Bergtheil, Agricultural Bacteriologist to the Pusa Estate 99

APPENDIX B.—Jute Experiments in Bengal, by Mr. R. S. Finlow, B. Sc., F.C.S., Jute Specialist to the Government of Bengal 105

APPENDIX C.—Outline of the history and the work done by the Mysore State Department of Agriculture, by Dr. A. Lehmann, Ph. D., Agricultural Chemist to the Government of Mysore. 108

APPENDIX D.—List of recent agricultural publications in India . 110

PREFACE.

AS this is the first annual report published by the Imperial Department of Agriculture, it includes not only an account of the work of the past year, but a summary of that done since the appointment of the Inspector General in 1901. The first part consists of the Report of the Inspector General, which gives a general account of the Department, a summary of the work done by the members of the scientific staff, an account of the special investigations made by or at the instance of the Imperial Department, a resumé of the work of the provincial departments, and finally an outline of the proposals for future expansion. The remaining parts are the annual reports of the scientific officers of the subordinate branches of the Imperial Department, namely those of the Director of the Pusa Institute, the Agricultural Chemist, the Cryptogamic Botanist and the Government Entomologist. The appendices include accounts of the special investigations of indigo and jute, a summary of the work of the Mysore State Department of Agriculture, and a list of recent publications relating to Indian agriculture.

ANNUAL REPORT

OF THE

IMPERIAL DEPARTMENT OF AGRICULTURE

FOR

1904-05.

Part I.

REPORT OF THE INSPECTOR GENERAL OF AGRICULTURE.

1. **Duties of the Inspector General.**—The post of the Inspector General of Agriculture in India was created in October, 1901, to which Mr. J. Mollison, M.R.A.C., was appointed. He held it until November, 1904, when he proceeded on one year's leave, and Mr. F. G. Sly, I.C.S., was appointed to officiate for him. The Inspector General is the administrative head of the Imperial Department of Agriculture and the scientific adviser in agricultural matters to both the Imperial and Provincial Governments. It is his duty 'to guide and co-ordinate the experiments which are being made under the orders of Local Governments and to publish and criticise their results, to indicate new lines of experiments which they may profitably follow, and to respond to the requests of private investigators for assistance or advice.' He is not invested with any direct authority over provincial departments of agriculture, and the experience of the past four years shows that such authority is not required, for provincial Directors freely consult him and welcome such advice and assistance as he can give.

2. **Staff.**—When the appointment was created in 1901, two experts only were attached to the Imperial Staff,—the Agricultural Chemist and the Cryptogamic Botanist. There are now eleven appointments in the Imperial Department:—(1) Inspector General, (2) Assistant Inspector General, (3) Director, Pusa Institute, (4) Agricultural Chemist, (5)

Cryptogamic Botanist, (6) Entomologist, (7) Agri-Horticulturist, (8) Supernumerary Agriculturist, (9) Biological Botanist, (10) Agri-Bacteriologist, and (11) Second Entomologist. During the same period the expert staff of provincial departments has similarly been strengthened. Madras, Bombay and the United Provinces alone employed expert agriculturists as Deputy Directors, and the Economic Botanist in Madras was the sole representative of the specialized sciences. Now Deputy Directors have been appointed for Bengal, Punjab and the Central Provinces; an Economic Botanist, an agricultural chemist and a professor of agriculture have been added to the Bombay staff, an Economic Botanist to the United Provinces, and an Agricultural Chemist to the Central Provinces. The staff of experts employed by Government has thus increased from six to twenty-five during the past four years. The inspection tours of the Inspector General have persistently brought to notice the imperative necessity for the employment of scientific experts in guiding and controlling the work of agricultural departments, so that the main problem of the application of science to Indian agriculture may be properly investigated.

3. **Tours.**—The head-quarters of the Inspector General are located at Nagpur (Central Provinces), which is a convenient centre for inspection duty. The past four years have been spent in almost constant touring throughout India, all the provinces having been visited at least once, and most of them several times. These tours have enabled the Inspector General to make the close acquaintance of the provincial directors and their staff, with whom the maintenance of friendly relations is the first essential to success in his work. Secondly, he has studied on the spot the experiment stations and other lines of work in progress, which has enabled him to make recommendations for their improvement. Thirdly, he has obtained a general view of the agricultural conditions in each province, which has allowed him to prepare working schemes for the consideration of local officers. The more important action resulting from these tours will appear in the subsequent notice of the work of each provincial department, but I may refer to one great advantage which has accrued from the appointment of an Inspector General. All provincial departments have been brought more closely into touch with each other, thus removing the isolation of the work carried on in each province. In a similar direction much good resulted from a general tour to the experimental farms of the Bombay Presidency in 1903, which was made under the guidance of the Inspector General by the Directors of Bombay, Punjab and the Central

Provinces, the Deputy Director and the Economic Botanist of Madras, the Agricultural Chemist of the Mysore State, and the expert staff of the Bombay Department of Agriculture. It is desirable to arrange similar occasional tours in other provinces, if the officers can be spared to attend them.

4. **Board of Agriculture.**—Another advance in the same direction has been made by the creation of the Board of Agriculture which meets annually at Pusa. This Board consists of the Inspector General (who is the President) and the Imperial staff, the provincial Directors and their expert staffs, the Inspector General, Civil Veterinary Department, Director of the Botanical Survey and Director of Public Instruction, Bengal. It discusses the programmes of the imperial and provincial departments, and advises Government as to the action that should be taken for the improvement of Indian agriculture. This annual meeting thus affords to the agricultural experts working in different parts of India an opportunity of exchanging ideas with each other, of learning what is being done in the various provinces, of co-ordinating their work and of advising on agricultural administration generally. The recommendations of the Board are submitted to the Government of India for their consideration. The first meeting was held in January last and was attended by thirty members. The proceedings * of the Board have been separately published, the principal subjects that came under discussion being the year's programmes of the imperial and provincial departments, the improvement of cotton cultivation, the extension of jute cultivation, agricultural education, irrigation, cattle breeding, measures for regulating the relations between the imperial and provincial departments, measures for bringing the department into touch with cultivators, and publications. Several of the recommendations have been accepted by the Government of India, whilst others are still under their consideration. The universal opinion of the members was that the first meeting had proved of great utility.

5. **The Agricultural Research Institute, Pusa.**—A most important development of the imperial department occurred in 1903, when the Government of India sanctioned the establishment of an Imperial Agricultural Research Station and College, which includes fully equipped laboratories for research work, an experimental farm, a cattle breeding farm and a higher Agricultural College. This Institute is located on a Government estate of 1,358 acres at Pusa in Behar, the most thickly

* Proceedings of the Board of Agriculture, Government Printing Press, Calcutta.

populated agricultural tract of India, which will be the head-quarters of the Imperial scientific staff. Apart from the value of the estate, the buildings will cost some R16½ lakhs (£110,000), towards which has been applied a portion of the magnificent donation of £30,000 made by Mr. Phipps, an American gentleman, who during a visit to India placed this gift at the disposal of His Excellency the Viceroy, Lord Curzon. The main building will include fully equipped laboratories for all the specialists, herbarium, museum and library, together with hall, lecture rooms and laboratories for the students of the College. The farm will provide experimental cultivation for the research work and for the training of the students; it is hoped that it will serve as a model for similar stations under provincial departments. The Agricultural College, with a full staff of professors and assistants, will provide a specialized post-graduate agricultural education in the hope that the best of the native students will be ultimately fit for the higher appointments in the agricultural departments. It will also give to students a good agricultural education to fit them for employment by Government in the revenue service and by land owners as estate agents and the like. It is anticipated that the College will be ready to open about the end of 1907. The cattle farm is intended to provide a supply of good bulls for distribution to the adjoining tracts of Bengal for the improvement of the indigenous breed of cattle. It is thus intended that the expert staff of the Pusa Institute shall conduct higher lines of research work applicable to all India and beyond the capacity of provincial departments, guide and assist the provincial experts in their several branches, train young scientists for future employment as provincial experts and be the professors of the higher grade Agricultural College for all India. The Report of the Director (Part II of this report) shows the progress that has been made towards the realization of this scheme. Mr. B. Coventry took up the appointment of Director in April 1904, and the complete staff of specialists has now been recruited, although they are not yet all resident at Pusa. Substantial progress has been made with the erection of the necessary buildings. A large part of the farm land has been reclaimed from waste and brought under cultivation, but it must take some few years to bring the land into a suitable uniform condition for regular experimental work. During the past year a start has been made in the testing of different varieties of crops, whilst experiments have been tried with many varieties of cotton in order to discover a fine quality that will suit the agricultural conditions of Behar. These preliminary trials seem to repeat the result of

similar efforts in many other parts of India, that it is very difficult to introduce exotics successfully and that the most hopeful line of work is to breed a suitable variety from the indigenous races. Pending the opening of the College, some provincial candidates have been trained in practical agriculture and entomology, in order to qualify them for posts in provincial departments. This start met with such success that arrangements have now been made to train similar candidates in practical agriculture, agricultural chemistry, mycology and entomology. In view of the importance of securing quickly the nucleus of a staff of trained assistants in each province, this temporary arrangement should be of much utility to provincial departments.

6. **Agricultural Chemistry.**—In addition to a large number of analyses of agricultural materials (soils, manures, feeding stuffs, waters and the like) made at the instance of provincial departments, several special problems have been under investigation, an account of which is given in Dr. Leather's report (Part III). His relief from the duty of delivering courses of elementary lectures at Poona, Madras and Dehra Dun has given more time for specialized work. A large number of samples of Indian food-grains and fodders, many of which are foreign to European agriculture, have been analysed to determine their comparative value, and the results have been published in Agricultural Ledgers Nos. 10 of 1901 and 7 of 1904. A similar inquiry has been made to determine the amount of oil contained in different varieties of oil seeds, collected from all parts of India. These have given some most interesting results, which may prove of commercial importance, large variations being found in the oil-content of samples of oil seeds received from different parts, more particularly of earthnuts, sessamum, mustard and safflower. The inquiry has now to be carried to the second stage by the experimental cultivation of the best oil-yielding varieties, to test the comparative gross outturns and to see if the quality is dependent upon local conditions of soil, climate and cultivation, or is maintained after transfer to other surroundings. Dr. Leather has co-operated in the investigations made at the Manjri (Poona) Sewage Farm into the agricultural value of purified sewage, the best treatment needed for its purification, and the extent of land required to take the sewage from a given population; chemical inquiry has been made to ascertain the degree of purification effected, the size of septic tank suitable for definite quantities of sewage of different strengths, and the necessity for aerated beds. These experiments have necessarily been made under artificial conditions, which somewhat

detract from the utility of the results, but definite conclusions have been arrived at as regards the manurial value of the septic tank effluent, the kinds of crops most suited to a sewage farm, the best system of cultivation and the area required to utilize the sewage from a given population. The Agricultural Chemist has similarly assisted in an inquiry into the sugarcane cultivation of the Central Provinces, an assistant being deputed during the harvesting season in order to analyse the different varieties of cane. Very marked differences in the quality of the varieties of cane have been found, most of them being poor, but one variety contained no less than 22·40 per cent. of cane sugar, which equals that of the best canes known to be in cultivation. Other important results have been obtained from sugar experiments in Bombay and the United Provinces of Agra and Oudh, which are given in Dr. Leather's report (Part III). Attempts have been made to determine various chemico-agricultural questions by the growth of plants under 'pot-culture methods,' more particularly in regard to the soil requirements of lime, sulphates and phosphates, its physical nature, moisture conditions and other matters which cannot be determined by chemical analysis alone. This branch of work has been started under difficulties but a proper pot-culture house is now under construction at Pusa. The preliminary investigation into saline earths has largely been completed, the nature and quantity of the salts having been determined by the analysis of numerous samples. This has assisted the experiments in reclamation in progress in the United Provinces and Madras, but at present the cost of any successful known treatment seems to exceed the value of such reclaimed land. An interesting inquiry has been started to ascertain the amount of nitrogen added to the soil by rain water and dew and lost to it by drainage. The amount of combined nitrogen in rain and dew has been investigated at Dehra Dun and Cawnpore, whilst drain-gauges have been erected at Cawnpore to determine the loss of nitrogen by drainage. It is hoped that these gauges will also furnish information of interest to the Irrigation Department in regard to the velocity of percolation, the amount of evaporation and such like matters. Dr. Leather has written a note on 'Water in the Soil,' which gives some interesting preliminary deductions on this important subject. Dr. Leather's report shows that a very large amount of useful work has been done by him during the past four years, but as in other branches of specialized science much of it has been in the nature of the preliminary investigation of many important problems. With the numerous demands made upon a single

chemist, it is impossible for him to concentrate his time upon a complete inquiry into a few definite problems, which again emphasises the necessity for a large increase in the number of specialists.

7. Saltpetre as manure.—Experiments to test the value of Indian saltpetre (nitrate of potash) as a manure have for many years been made at several provincial experiment stations. At Cawnpore, it has been found that crude saltpetre increases the yield per acre of maize from about 740 to 1,020 lbs. and of wheat from 1,270 to 1,710 lbs. (see North-West Provinces Bulletin No. 9 of 1900). At Nagpur, its use has increased the yield of wheat by 300 to 450 lbs. Similar results have been obtained at Dumraon. Extensive trials in the Bombay Presidency show that saltpetre gives a largely increased yield of rice under favourable conditions, but in porous soils much of this soluble manure is liable to be washed away unless applied at a suitable time. The best results have been obtained at Burdwan, where an application of bonemeal (3 maunds) and saltpetre (60 lbs.) has given an average yield of 4,350 lbs, of paddy as against 1,480 lbs. unmanured, giving an excess net profit of R100 an acre. Crude saltpetre has thus almost universally proved itself a valuable manure for cereals. An inquiry was, therefore, started by the Inspector General of Agriculture to see if any practical measures could be devised to increase and cheapen the production of saltpetre and to extend its use amongst cultivators. An investigation into the manufacturing processes was made first by Mr. Hooper and later by Dr. Leather, the results of which will shortly be published as an Agricultural Ledger. No practical measures for improving these processes could be suggested, the workers already making the best use of the available materials within the economic limit of their surroundings. The production is controlled by the Salt Department under a system of licenses. An inquiry was made, in consultation with the Commissioner of Northern India Salt Revenue, to see if any modification of this license system could be devised which would lessen the amount of Government interference and cheapen the product. It is clearly impossible to abolish all supervision, for there are extensive tracts of salt earths in India, which have produced enormous quantities of salt in former years, and which would be worked again under the guise of saltpetre works. The methods of extracting saltpetre and salt from suitable earths are practically identical, so that any freeing of the former is impracticable so long as government controls the manufacture of salt. The workers, who separate the crude saltpetre from the nitrous earth, could easily separate an edible salt by the same

processes, but for the same reasons it is not possible to permit it. The present small license fees have no appreciable effect upon the price of saltpetre, which is regulated by the export trade, so that no reduction in the license fees would make any real difference in the price of saltpetre. The very small extra profit would be absorbed mostly by the landlord who leases the area of nitrous earth, and to a smaller extent by the crude saltpetre workers and the refiners. In order to lessen the supervision and consequent interference with the refineries, it was suggested that the license fee might be regulated by the number and size of the boiling pans employed, instead of levying a fixed duty on the refinery and a tax on all salt excised from it, but this system would prove unequal owing to the very varying amount of salt in the crude material. The imperial department of agriculture was, therefore, unable to make any practical proposals for cheapening saltpetre, although such a result would be of great benefit to Indian agriculture. At present prices it is not a cheap manure. The price of refined saltpetre is about £9 to £11 per ton in Calcutta, whilst Chili saltpetre (nitrate of soda) can be landed at about £11 per ton. The potash of Indian saltpetre has probably not a great manurial value in India, whilst the price per unit of nitrogen is somewhat in favour of Chili saltpetre. Indian saltpetre (nitrate of potash) is more valuable in certain industries than Chili saltpetre (nitrate of soda), so that its present price is independent of agriculture. The present aim of the Inspector General is, therefore, limited to extending the use of saltpetre as a manure. Nitrous earth is used by cultivators in tracts where there is an available local supply more particularly for tobacco, wheat, potatoes and garden crops. The price of crude saltpetre is largely regulated by the price of the refined material. At ordinary prices, it is somewhat cheaper to use as manure near the source of supply, but the railway freight on this bulky material makes it less profitable at a distance. Demonstrations of the use of saltpetre as a manure have been made on an extensive scale in cultivators' fields in the Central Provinces and Bombay with promising results. This year a large free issue of bonemeal and saltpetre has been made out of funds supplied by the Inspector General to cultivators around Burdwan, where such excellent results have been secured from its use on the experimental farm. By such means, it is hoped in time to bring it into general use. Another subject, investigated during this inquiry, was the utilization of *Sitta*, or impure saltpetre salt, which is a by-product of the refineries. Experiments were made to test its suitability as a substitute for common salt in cattle food, by giving it

to cattle at several Government Cattle Farms. At some farms its use caused no ill effects, but at others it was followed by diarrhœa and abortion. It varies very largely in its composition, containing from 25 to 85 per cent. of sodium chloride. The safety clearly depends on its purity but it may generally be said that the mixture of potasium nitrate with some lime and magnesia makes it an unsafe food. In all cases it was found that the price (including freight) was equal to, if not in excess of, the price of common salt; and the quantity available is too small to make any real difference in the price of the salt required for cattle.

8. **Mineral Fertilizers.**—The possibility of encouraging the use of mineral fertilizers has been under consideration, the question having been raised by the Board of Scientific Advice. Phosphatic manures, mostly in the form of crushed bones and superphosphate, have been under trial for several years at some government farms. Their use has not generally been characterized by any great increase of crop yield except at the Burdwan farm (see paragraph 7 above). The high price of superphosphate in India prohibits its general use under existing agricultural conditions, whilst crushed bones act too slowly to be of use in most soils. The establishment of a sulphuric acid industry might alter these conditions, but phosphoric acid is not generally deficient in Indian soils except in the Gangetic alluvium. Phosphates occur in the form of apatite as a by-product of the mica mines of Chota Nagpur, but the output is too small to be of any importance. This phosphate has been tried on a small scale with poor results. Phosphatic nodules are found in large quantities at or near the surface in the Trichinopoly district of Madras. Analysis showed that the amount of phosphate of lime is fairly high comparing favourably with Carolina and English coprolites, but it is not well suited for the manufacture of superphosphate, as the quantities of carbonate of lime, iron and alumina are high, involving waste of sulphuric acid. It would thus probably pay neither to export nor to manufacture. It might be used as a slow acting fertilizer in a crushed state but the freight charges by road are very heavy. It is already worked on a small scale to provide manure for coffee estates. The phoshate of lime found in the Christmas Islands, which is shipped largely to Japan, Australia and Europe for use by artificial fertilizer manufacturers, can be landed in bulk at Calcutta at about £2-10-0 per ton, but in its raw state it could hardly compete with bones at their present prices, making allowance for the nitrogen in the bones. Christmas Island phosphates

might, however, be less costly than any indigenous material if a sulphuric acid industry could be established. The analysis of these materials is compared in the following table.

Constituent.	Percentage of different constituents in the samples.		
	Apatite. Hazaribagh mica mines (*a*).	Trichinopoly phosphate (*a*).	Christmas Island phosphate (*b*).
Moisture	0·37	1·62	0·74
Organic matter	...	2·71	2·80
Lime	36·42	37·22	...
Iron and alumina	1·89	11·90	2·01
Alkalis, etc.	3·00	7·76	...
Phosphoric acid	28·39	22·83	38·89
Carbonic acid	0·03	5·56	1·95
Silica	29·90	10·40	0·10
Calcium phosphate	61·98	49·84	84·90
Calcium carbonate	...	12·62	4·43

(*a*) Analyses made by Dr. Leather, Agricultural Chemist to the Government of India.
(*b*) Analysis supplied by the Director, Geological Survey of India.

Gypsum is found in large quantities in the Salt Range of northern India and is locally obtainable in smaller quantity at several places. It deserves special notice because it is an antidote to certain classes of saline soils (*usar* or *reh*), but the cost of reclamation with gypsum is more than the value of the land owing to the heavy freight charges by road and rail. Nitrate of soda has lately been tried at several experiment stations, but the results are not definite. The use of artificial fertilizers seems to be coming nearer within the scope of Indian agriculture, and a regular series of trials upon cotton at government farms has been recommended by the Inspector General of Agriculture.

9. **Mycology.**—Since his appointment in 1902, Dr. Butler, Cryptogamic Botanist to the Government of India, has principally been employed upon a preliminary survey of the important fungus diseases of Indian crops, which has resulted in the collection of a mass of

material, much of which still remains to be worked up. The forming of a type collection of fungi and its detailed examination are the necessary preliminaries to work of a more directly economic nature. The investigation of several important fungus diseases has been carried through the first stage. Much attention has been given to the very serious wheat rusts, which are dealt with in the following paragraph. The fungus diseases of sugarcane have also been investigated, particularly red-rot, caused by *Colletotrichum falcatum*, which causes enormous losses in many parts of India. So far as this inquiry has proceeded, it seems probable that this disease is largely, if not solely, extended by the planting of diseased sets. If this is the case, every cultivator can easily control it by selecting only healthy unreddened sets for planting. A wilt disease of the pigeon pea (arhar or tur, *Cajanus indicus*), caused by a *Nectria* fungus, is very prevalent over Northern, Central and Western India. The same fungus is responsible for the serious outbreak of disease in the pepper vine gardens of Western India. No direct methods of attack have proved successful, and the only remedy seems to be to breed resistant varieties. This line of work has been taken up for pigeon pea at the Bombay farms, whilst the Madras department has started a special experiment station for pepper in Malabar. The ground-nut leaf disease is noticed in paragraph 11 below. Some of the smuts of cereals have been successfully combated by methods of steeping the seed. This treatment has been carried beyond the experimental stage in the Central Provinces, where demonstrations have been made over large areas with the result that it is being rapidly adopted by the cultivators for the eradication of smut in juar (*Andropogon sorghum*). Owing to the fact that the Agri-Bacteriologist has not yet joined the Imperial staff, Dr. Butler was directed to make some preliminary trials of Dr. Moore's methods of cultivating the nitrogen-fixing bacilli of leguminosæ. The nodule bacilli of the pigeon pea (*Cajanus indicus*) have been successfully cultivated by these methods. It yet remains to be seen whether such cultures will have much effect on crop outturns in India. The system of growing pulses in rotation is so common as to make it improbable that there is a practical field for the use of such cultures, unless they prove much more virulent than the bacteria with which the soil is already impregnated. Similar work is being done by Mr. Bergtheil on indigo, and the whole subject will be taken up by him when he joins the Pusa staff as Bacteriologist. Much excellent work has been done by Dr. Butler, who single-handed has prepared

the way for the complete investigation of several important problems. Each important province requires a Mycologist on its staff before much rapid progress can be made. It seems improbable that direct methods of attack, such as spraying, can come into general use for the treatment of field crops in the present stage of Indian agriculture. Some good may result from less expensive methods, such as the steeping of seeds and the destruction of diseased plants, and there is undoubtedly a wide field for the introduction of preventive measures in the breeding of resistant varieties and the supply of disease-free seed.

10. **Wheat Rusts.**—A special investigation into the wheat cultivation of India is in progress, mainly with the object of securing a rust-resistant variety of good commercial value. The many cultivated varieties were collected by the Inspector General in 1902 and distributed to several Government farms for experimental cultivation in order to study their characters, to ascertain which possess rust-resisting qualities, and to commence cross-breeding from selected varieties in the endeavour to produce a rust-proof hybrid. These experiments are being conducted at Poona, Cawnpore, Nagpur and Lyallpur. As a result of the observations made on the many varieties under growth at Poona, Professor Gammie, Economic Botanist, issued in 1903 'A provisional classification of the Indian Wheats'. There was a bad outbreak of rust in 1902, which gave much information as to the rust-resisting qualities of the many varieties. It was generally noticed on the Bombay farms that the hard wheat varieties were more severely attacked than the soft varieties. It was also found that a variety which resists rust in one part is liable to attack in another climate, which shows that each province must work independently in this matter. Cross-breeding experiments are being systematically carried out at Poona and at Cawnpore, but the urgent need of an expert botanist to control these operations is felt everywhere. At Cawnpore the line of investigation includes sterilization and segregation experiments with wheat in order to test Eriksson's mycoplasma theory; endeavours to obtain germinating teleutospores or resting spores, and to ascertain any possibility of transmission of the disease by these spores; testing the vitality of the uredospores and the possibility of the disease being carried over from one season to another by these spores; testing the possibility of transmitting wheat rust to other cereals and plants and *vice versâ*. Dr. Butler, in co-operation with the provincial departments, has determined the several species of rust and is working out their life history. The general method of infection has yet to be

determined, but in some kinds of rust it seems doubtful whether any other plant has any influence on the spread of the disease. Climatic conditions are a most important factor. The preliminary results of Dr. Butler's investigation have been published in a note on 'The Indian Wheat Rust Problem, Part I,' as Bulletin No. 1 of 1903 of the imperial department of agriculture. India is rapidly assuming a most prominent position amongst the wheat-producing countries of the world and the crop demands special attention, not only in regard to the prevention of rust but to the improvement of the milling and baking qualities of the varieties cultivated for export. A special expert is required to guide and assist the experiments conducted throughout the several provinces.

11. **Ground-nut Leaf Disease.**—The important ground-nut (*Arachis hypogœa*) cultivation of the Bombay Presidency has rapidly declined of recent years mainly owing to a fungus disease (*Septogloeum arachidis*) locally known as *tikka*, a description of which is given in paragraph 27 of Dr. Butler's report (Part IV). This disease is also extending in the Madras Presidency. Spraying has not been successful, but if the surmise is correct that infection is carried in the seed, seed-treatment may be possible. Efforts have mainly been directed towards securing a disease-resistant variety. With this object varieties have been obtained from Japan, America, Africa, Spain and Mauritius. These are all being tested on the Bombay farms both for disease-resisting qualities and for yield in this country. A new farm has been started in South Arcot (Madras) as a ground-nut experiment station, where this disease will be fully investigated. The best of the foreign varieties were also distributed for trial in different parts of India. The cultivation at Pusa was a failure owing to the attacks of caterpillars. In other parts, the 'Virginian' and 'Pondicherry' varieties seem to have done the best. The oil-yielding quality has been determined by the Agricultural Chemist to the Government of India, who found that the percentage in the kernels varied from 40 to 50, the 'Mauritius' varieties grown in Madras generally giving the best results. The indigenous varieties contain from 39 to 44 per cent. of oil. 'Virginia' gave 44·33 per cent., and 'Japanese small' 49·75 per cent.

12. **Entomology.**—The work of the Government Entomologist may similarly be divided into two heads — the systematic survey of insect pests and special investigations. Since Mr. Lefroy was appointed Entomologist to the Government of India in April, 1903, he has done a great deal towards making a collection of insect pests, but much of the material yet remains to be worked up and identified by specialists

in the several groups of insects. He has also made a complete field investigation of the insect pests of Guzerat and Behar, where his headquarters have been located. In his report (Part V), he rightly places the greatest importance upon the study of insect pests in the field. The training of a small number of provincial assistants to work as fieldmen in some provinces has been a most promising feature of his labours, for these men have done excellent work under his guidance. His remarks as to the necessity for a large expansion of this kind of establishment will doubtless receive the attention of provincial departments. Mr. Lefroy also indicates the lines upon which entomology should proceed in order to produce practical results upon the agriculture of the country. He points out that elaborate and expensive methods of attacking insect pests are not likely to be adopted by the Indian ryot, so that attention should be concentrated upon the simplification of such processes. It is improbable that the spraying of field crops with expensive mixtures will ever come into general use, but there are other remedies, mechanical and otherwise, which have considerable promise. The relations of the Government Entomologist with the Indian Museum (which possesses a large collection and which was previously responsible for entomological work) have been placed upon a satisfactory basis. Among special investigations the Bombay locust has been the most prominent subject of study, the results of which are given in the next paragraph. A special inquiry was also made into the insect pests of coffee, the results of which were published as bulletin No. 2 of 1903 of the Imperial Department of Agriculture. Mr. Lefroy's enthusiasm has overcome to a large extent the many difficulties with which he has had to contend and which are inherent in the starting of a new branch of scientific inquiry. The facilities that will be afforded by Pusa will remove all difficulties of importance. The imperative necessity for a considerable expansion of the staff of specialists, both Imperial and Provincial, is forcibly shown.

13. **The Bombay Locust.**—A plague of Bombay locusts (*Acridium succinctum*) caused considerable damage in the Bombay Presidency and the Central Provinces in the early part of 1904. In conjunction with officers of the Bombay Agricultural Department, a special inquiry was made into these important pests, and practical measures were undertaken for their destruction. The life history of the Bombay locust has now been completely worked out for the first time. Trials were made both in Bombay and in the Central Provinces of many methods for destroying these pests. The simpler methods proved the most successful,

such as the collection of the hoppers in suitable bags dragged by men over the young crops, the driving of hoppers into pans of kerosine oil, the destruction of locusts during the time of coupling, the collection of eggs and the like. The sum expended in this campaign amounted to some R2 lakhs in Bombay and R10,500 in the Central Provinces. Enormous numbers were destroyed, and the swarms that came to maturity were far smaller in number than in the previous year. Mr. Lefroy has prepared a report on the Bombay locust, which will shortly be published. In past years several trials have been made of Dr. Edington's South African fungus for the destruction of locusts. These trials were uniformly unsuccessful and were abandoned. The Kew authorities have recently suggested that the failure may be due to incorrect methods, so that it has been decided to make a careful test of the efficacy of the fungus cultures on a small scale under proper conditions of control by the Government Entomologist and Cryptogamic Botanist working together, which should finally settle whether this method is of any use in India.

14. **Grasshoppers.**—Large plagues of grasshoppers (*Acrididæ*) have for some years caused much damage to the rice crop in parts of the Central Provinces. At the instance of the provincial department, the Inspector General of Agriculture arranged for the deputation of Mr. Stewart Stockman, Assistant to the Imperial Bacteriologist, for an inquiry into this pest in 1902. Mr. Stockman made a most careful investigation of this pest and tried many remedies, with the result that he devised a practical method for their destruction by the dragging of nets over the fields. This method has been worked on a large scale, and has been found to be most successful in clearing considerable tracts. It necessitates united action by all the cultivators in the same tract, so that the campaign must be organised and supervised by government officers. A full account of Mr. Stockman's inquiry has been published as Agricultural Ledger No. 3 of 1903.

15. **Cotton :—Survey of indigenous varieties.**—During the past four years measures for the improvement of Indian cotton have absorbed a very large proportion of the energies of the imperial and provincial departments. A full account of these measures has already been published in the proceedings of the Board of Agriculture so that this report will be confined to a general summary. In 1902 the Inspector General made a collection of the existing varieties of cotton cultivated in India. The percentage of lint to seed yielded by each variety was ascertained, and a valuation of the lint was made by trade

experts, which serves as a standard for future comparison. These varieties were distributed to Government experiment stations in the principal cotton-growing tracts to serve as a basis for botanical examination and identification and also to test the most suitable varieties for growth in each tract. As regards the botanical survey, a preliminary classification * was issued by Professor Gammie in 1903, and a second paper by him on the same subject is now in the press. This preliminary stage of the botanical survey is then completed for the present. Some interesting results have also been obtained by the growth of numerous varieties side by side in order to judge of their comparative values under varying conditions of soil and climate. These have been published in Mr. Mollison's two Notes on the Improvement of Indian Cotton, dated the 3rd February and 15th August, 1903. Field examination shows that the agricultural characters of different varieties are very much modified by transferring them from one tract to another. The modification may result in deterioration or the reverse, as regards vigour of growth, yield, quality of lint and proportion of lint to seed. A favourable season also affects the quality of the lint and its percentage to the seed. Most varieties have inherent characteristics that suit the local conditions. Varieties of the fine *Broach* type generally deteriorate when grown away from the genial influence of sea breezes. With their prolonged period of growth, they also require either deep moisture-holding soil or the assistance of irrigation. Extensive trials of the Broach variety were made in 1904, seed being distributed to Government farms and selected private persons. These proved almost universally a failure, being damaged in some parts by heavy monsoon rains and in others by winter cold. It may be that this type may succeed with early sowings under irrigation in the north of India, where very inferior varieties are at present grown. Early sowing is necessary so that the crop may be mature before the cold season arrests growth. The fine varieties of the *Bani* type come to early maturity, but are delicate and give a small yield with a low percentage of lint. Selection and cross-breeding to improve the yield and vigour of the plants is the most likely method of improvement. The coarse varieties of the *Jari* type are vigorous, hardy plants, giving a heavy yield and a high percentage of lint. The growth of this type is rapidly expanding and will not be ousted until a finer variety can be introduced which will give an equally large

* Note on the classification of Indian cottons at the Poona Farm by G. A. Gammie, F.L.S.

profit. The *Jethi* type is also extremely vigorous and prolific, but the lint is poor and its percentage to seed is small.

16. **Selection of seed.**—It seems probable that in most tracts improvement is more likely to result from working with the indigenous variety as a basis rather than the introduction of another variety. The two main methods of improvement are selection of seed and cross-breeding. In some tracts the cultivators practise no seed selection, whilst the increase of ginning factories has resulted in the mixture of seed and further deterioration in parts where the cultivators purchase their seed from such factories. Careful plant-to-plant selection upon scientific lines is proceeding at some government farms, which should result in future improvement. A proposal to start some large government seed farms has been negatived, but it has been decided to start an experiment station in each important cotton tract, which will contain a substantial area for seed selection and production. Efforts have been made to produce quicker results by a rougher method of selection. Under the instructions of the Government of India and with their financial support, provincial departments have arranged to help cultivators in securing the best seed of varieties known to be suitable to the local conditions, in the hope that this may result in the production of better cotton than is now produced by seed indiscriminately obtained from all sources. The methods followed have naturally varied with local conditions. In tracts where the cultivators obtain their seed from ginning factories, arrangements have been made with the owners to set aside the best lots of cotton purchased by them, to remove all stained lint and to gin separately for seed distribution. In other tracts, the best fields of cotton have been selected, from which all weakly plants and stray plants of other varieties are removed, and the best pickings taken for seed. An interesting trial of private seed farms is also being made in the Central Provinces by inducing some cultivators to grow cotton primarily for seed upon principles which differ somewhat from those followed in growing the crop for lint, with a government guarantee against loss and government assistance in trained supervision. It is clear that such generalized methods are only applicable to tracts where the cultivators themselves do not practise seed selection; the results have yet to be ascertained.

17. **Hybridization.**—The most hopeful line of work is plant-breeding, which is in progress on several farms, more particularly in the Bombay Presidency. This work was started in 1901, but it was

not till the following year that a regular programme was framed. Progress must necessarily be slow, but there is a distinct promise of some ultimate success. Everywhere the need of control by experts has been acutely felt. Crosses have been made of one indigenous variety with itself and with a second indigenous variety. The result of crossing *inter se* has generally been to produce a marked increase in the vigour of growth. This has been very marked at Surat and at Lyallpur, but no improvement is reported to have resulted from similar work in Madras. Crossing of one variety with another at first results in great variation of type. These hybrids are now undergoing a rigorous course of selection both for improved fibre and for improved yield. Several of the many hundreds of crosses have shown marked superiority over both parents. There are a few hybrids in cultivation on the Surat farm that can hardly fail to improve the Broach type. The work has received a sharp check from the very unfavourable season of last year when all that could be done was to save the crop by irrigation, but with two favourable years the provincial department should be in a position to distribute new varieties to cultivators. In other provinces the work is much less advanced or at a standstill owing to want of skilled supervision.

18. **Trial of exotics.**—Whilst attention has very largely been concentrated upon the improvement of indigenous varieties, the trial of exotics has not been neglected, although the persistent efforts of many years past have nearly always ended in failure. Exotics, even when acclimatized, are generally more delicate than indigenous varieties and deteriorate rapidly. In 1902 trials were made of a number of newly imported American and Egyptian varieties. They were sown as an ordinary monsoon crop, and failed everywhere on black soil. The small amount of lint produced was also found to have greatly deteriorated. The experiments were continued in 1903, the second year's crop being somewhat better than the previous one. Extensive trials of American and Egyptian varieties were made in 1904 in Behar and the Punjab. The Behar trials were generally a failure. Newly imported Americans and Egyptians were found to be risky to grow and did not thrive; the superior indigenous varieties matured so slowly that they were affected by the winter frost; acclimatized Americans did the best, but even these largely failed. The problem of cotton cultivation in Behar is still unsolved. In the Punjab a promising measure of success was obtained with some American varieties, both newly imported and acclimatized. Extended trials are being made during the current year. Still more

promising results have been secured by Mr. Fletcher, Deputy Director of Bombay, with Egyptian cotton in Sindh. Small trials in 1904 gave a good yield quite equal to that obtained in Egypt, whilst the growth of the plant appeared to be normal. The valuation showed that some deterioration had occurred in the quality of the lint. It yet remains to be seen whether such deterioration will gradually increase, or whether it is merely temporary on account of the sudden change, from which the plant will recover. It is also possible that deterioration may be arrested by cross-fertilization. An area of 1,500 acres has been sown during the present year. It is altogether too early to pronounce any opinion upon these experiments, but it may safely be said that the first trials are promising. The introduction of exotics is not hopeless in the drier portions of India, where the monsoon rainfall is light and where irrigation is available for other periods. Deep alluvial soil with good natural drainage is much better suited to exotics than black cotton soil. Early sowing in April under irrigation has given the best results.

19. **Tree cottons.**—In the past few years considerable attention has been attracted to the perennial or tree cottons, some of which are known to produce fine lint. At present their cultivation is generally confined to a few stray plants in house gardens, the lint of which is used for weaving the sacred thread worn by high castes. A collection of the different varieties was made in 1904 by the Inspector General, preliminary trials being made at Poona and Pusa. The indigenous varieties with fuzzy seed nearly all yield lint of inferior quality, but some varieties of the rough Peruvian (naked seed) and Brazilian (clustered seed) types are more promising. These latter are probably the survival of foreign varieties introduced into India during the cotton experiments of the East India Company, which have become acclimatized and are much more immune to disease than newly imported seed. Large trials of tree cottons are being made by the Indian Long Staple Cotton Growing Syndicate (agents, Messrs. Shaw, Wallace & Co.) in Bengal, Assam and the Central Provinces. Towards the expenses of this pioneer work, the Government of India and the British Cotton Growing Association have agreed to contribute in equal shares a sum of £6,000. The Inspector General has assisted their work by exploring the different provinces of India for the collection of seed of the more promising varieties. This has thrown a considerable burden upon provincial departments, for it is most difficult to collect any quantity of seed from isolated plants in gardens scattered over very wide areas. Considerable quantities of seed of indigenous annuals have also been

supplied. The principal cotton farms of Messrs. Shaw, Wallace & Co. were inspected by the Inspector General, who wrote a note detailing the results and giving advice for the improvement of the methods of cultivation under trial. It is as yet too early to pronounce any opinion upon the possibilities of cultivating tree cotton as a field crop upon a commercial scale. Similar pioneer work is being conducted at Belgaum by Mr. Tytler with a rough Peruvian tree cotton. As some promising results were obtained by garden cultivation, Mr. Tytler has been assisted by Government in starting a plantation for experimental cultivation. Government has guaranteed half the actual net expenses after deducting the profits on sales, subject to a maximum payment of ₹5,000. There is some hope that this variety of tree cotton may prove suitable for cultivation on poor upland soil. Extensive trials of 'Caravonica' cottons (hybrid tree cottons raised by Mr. D. Thomatis of Queensland) were made in Assam and Behar. The results of the first trials are far from encouraging, the plants suffering from heavy rainfall, from frosts and from insect pests. Seed has now been distributed by the Inspector General to many government farms in order that this cotton may receive a fair trial throughout India.

20. **Improvement of methods of cultivation.**—Endeavours to improve the methods of cultivation have been made in several tracts, where it does not reach a high standard. The best cotton cultivators in India are the Guzeratis. Special parties of these trained cultivators with bullocks and implements were sent by the Inspector General to the Punjab and Behar in 1904, where they demonstrated proper methods of cultivation. This is reported to have given successful results. Similar efforts have, for a few years past, been made in the Central Provinces to improve the cotton cultivation in the backward parts of that province. Experiments in the manuring of cotton are in progress at several government farms. A circular letter to all provincial departments was also issued, recommending the trial not only of the local available manures, but also the chemical manures in general use in America.

21. **Extension of cotton cultivation.**—The possibilities of extending cotton cultivation in the Indian Empire have not been neglected. The experiments in the Punjab, Sindh, and Behar have been noticed above. In the Central Provinces cotton cultivation has extended to some new tracts, partly as the result of trials and demonstrations made by the provincial department. It has been suggested that Upper Burma is a suitable field for extension. This question has been examined by the Inspector General of Agriculture and by the Reporter on Economic

Products.* The circumstances of the small existing cotton cultivation were considered, but they do not seem to hold out much promise of a wide cultivation of fine varieties. The cotton now produced is inferior, the soil does not seem to be very suitable, transport is difficult, and there is a great scarcity of labour. Experimental trials must await the establishment of a provincial department of agriculture.

22. **Future expansion of cotton investigation.**—From the above account, it will be seen that a great deal of attention is being given by the departments of agriculture to the improvement of Indian cotton. In framing the programme, the Inspector General of Agriculture has received the assistance of the Board of Scientific Advice. This brief review of the cotton experiments may fittingly be closed by stating the principal recommendations of the Board of Agriculture for placing the department in a proper position to deal adequately with the problem. They include the appointment of an Imperial cotton expert to guide and correlate the experimental work throughout India; the strengthening of provincial departments by the employment of a full staff of experts, so as to permit of proper control of existing work and its future expansion; and the establishment of an experiment station in each important cotton tract, with a substantial area for seed selection and production.

23. **Cotton seed oil industry.**—The expansion of the cotton seed oil industry in America and England, coupled with a sudden large export of cotton seed from India, caused the Secretary of State to direct an inquiry into the possibility of encouraging the establishment of this industry in India. This question was referred to the Inspector General of Agriculture, who published the comprehensive information collected by him in Agricultural Ledger No. 9 of 1903. This dealt with the supply and prices of Indian cotton seed, the value of cotton seed as cattle food in India, feeding trials of undecorticated cake on Indian cattle, the percentage of oil, and other connected questions. A consignment of different varieties of cotton seed was sent to Hull, to test the adaptability of English machinery, the yield of oil and the feeding value of the cake. These tests were made under the supervision of Professor Gilchrist of Durham College, to whom the department is much indebted for assistance. The yield of oil from different varieties varied from 14·81 to 13·42 per cent. The feeding trials showed that Indian rough cotton-cake gave satisfactory results with

* 1. Report on cotton in Burma by Mr. I. H. Burkill, dated the 25th March 1904.
2. Report on the question of the possibility of extending cotton cultivation in Burma, by Mr. J. Mollison, dated the 15th August 1904.

stock fed indoors or on pasture, and that its high manurial value makes it a desirable manurial agent. Some further feeding experiments were made under the guidance of the Edinburgh College of Agriculture. Sheep and cattle were fed with several feeding stuffs with the result* that Bombay cotton-cake took the premier position in the sheep-feeding experiment and its right to that position was well supported by the results of the cattle-feeding experiment. These several trials have shown the suitability of English machinery for the treatment of Indian seed, the yield of oil that may be expected and the value of the cake as a feeding stuff. A considerable amount of information concerning the possibilities of this industry for India has thus been placed before the public, and the Government of India have decided that it is unnecessary for them to take any further action. Some cotton seed mills have indeed been established in India with varying results. Experience shows that whilst the oil can be sold in the country, the cake must be exported to Europe, because the Indian cultivator will not pay the price for this concentrated feeding stuff that can be obtained by exporting it. The success of a cotton seed mill largely depends upon the full and profitable utilization of all the by-products, which does not seem to be assured in India.

24. **Tea.**—The investigation of the scientific problems connected with the Tea industry is conducted by the Indian Tea Association with the support of an annual subsidy from government. The Scientific Department was started in April 1900, when Dr. Harold Mann, D.Sc., was appointed Scientific Officer, his laboratory being at Calcutta. The department was expanded in 1904 by the appointment of a second scientific officer (Mr. C. M. Hutchinson) and the establishment of a Tea experiment station at Jorhat (Assam) The following short summary of the scientific work is prepared from materials courteously supplied by Dr. Mann. There have been four main lines of scientific work— the study of (1) the tea soils of north-east India, (2) the manufacturing processes, (3) the fungus diseases, and (4) the insect pests. A survey of the tea soils was made with a view to ascertain what connection exists between soil and quality of tea, and also the most remunerative methods of treatment. Some interesting results of this survey have been published in two pamphlets "The Tea Soils of Assam" and "The Tea Soils of Cachar and Sylhet." The tea soils of the Duars are now under investigation, and it has been found that they are

* Report on Sheep and Cattle Feeding Experiments, by Mr. W. Bruce, B.Sc., F.H.A S. Bulletin No. IV of 1904 of the Edinburgh and East of Scotland College of Agriculture.

as a class richer than those of any district of north-east India with the exception of Darjeeling, and that with suitable methods they would probably yield a much higher quality tea than at present. The extreme importance of the physical texture of the land for tea culture is emphasised by this inquiry. An examination of the processes of tea manufacture was made in order to find out what actually takes place and the relation of each part of it to the production of high quality tea. The enzyme or unorganised ferment which is the principal agent of the changes, has been isolated and studied; the changes in its amount at various stages have been determined, with its effect upon the success of the process. These investigations have led to considerable improvements in the manufacture in several progressive factories. The results have been published in three pamphlets on "The Ferment of the Tea Leaf." An enquiry has been commenced into the changes in soluble matter and tannin which take place in tea during manufacture, which promises to furnish results of considerable importance. One of the most serious blights of the tea plant is that known as Red Rust, caused by an Alga (*Cephaleuros virescens*). An investigation of this alga and its effects has been made, with the result that the practical measures for preventing its growth and reducing the loss caused by it have been ascertained, including modifications in planting systems and direct methods of attack. Two bulletins have been published on Red Rust. The most serious insect pest of tea is the 'Mosquito Blight,' caused by a plant bug (*Helopeltis theiovora*). This has been under investigation during the past three years, and a method has been devised which, when the conditions are suitable for its application, has been successful in dealing with the blight. Two bulletins on 'The Mosquito Blight of Tea' have been published and a third is now in the press. At the Jorhat experiment station, tests are being made of the effect of manures on (*a*) the quality and (*b*) the yield of tea, the relative values of different green manures, methods of pruning, and methods of plucking for both quality and yield. These will in time give valuable results. The introduction of by-products on tea gardens has received a good deal of attention, including sisal hemp and rubber. A description of the culture of the former plant, based on foreign information and an examination of young plantations in the tea districts, was written by Messrs. Mann and Hunter and published in 1904 as 'Sisal-Hemp Culture.' The area under this fibre now amounts to several thousand acres. Rubber extension proceeds gradually; advice

is constantly asked for, and the Forest Department have promised to publish an account of its experiments with *Ficus elastica*. The manufacture of caffeine, which was suggested by Dr. Mann, has for the first time this year been started on a commercial scale. The Scientific Department has thus already achieved many important results, which justify an expansion of its work. In particular, the services of an Entomologist are required to investigate the serious insect pests of tea.

25. **Indigo.**—The scientific investigation of the Indigo industry is similarly carried out by the Behar Planters' Indigo Association assisted by a subsidy of government funds. An account of this investigation is given in the note printed as Appendix A of this report, written by Mr. C. Bergtheil, Agri-Bacteriologist of the Pusa Institute, whose services have been lent to the Association. The decay of the industry, owing to the competition of the synthetic indigo, has caused government to give special support to the efforts to revive it. Much work has been done in the investigation of the cultivation and manufacturing processes of indigo. Some improvements have been effected in the manufacturing processes, the chemistry and bacteriology of which have been carefully worked out. New methods of oxidization have been adopted by many factories. The enquiry into the improvement of the cultivation has not yet been so complete, but it has resulted in one important change—the introduction of the Java-Natal variety. This variety (*Indigofera arrecta*) is hardy and vigorous, and yields a much higher amount of indigotin than the variety ordinarily cultivated (*I. Summatrana*, formerly erroneously named *I. tinctoria*). It is now coming into general cultivation and will in all probability oust completely the common variety. The difficulty of bad germination has been overcome by the invention of a suitable scarifying machine. Many competent planters hold that the introduction of this variety will be sufficient alone to arrest the further decay of the industry, if not to result in its resuscitation. Manurial experiments show that Behar soils are deficient in phosphoric acid and nitrogen, and that artificial manures can be economically applied. A list of recent publications dealing with scientific work on Indigo is given in Appendix C.

26. **Jute.**—The investigation of jute was started in 1900, owing to a representation from the Calcutta Baled Jute Association that the fibre had considerably deteriorated in recent years. The Dundee Jute

Importers' Association also addressed the Government of India in 1901 on the same subject. An inquiry was taken up by the Bengal Department of Agriculture under the guidance of the Inspector General, and later on a special officer, Mr. R. S. Finlow, B.Sc., F.C.S., was employed as Jute Specialist. A short report by him is published as Appendix B of this report. The botanical examination of jute, first started by Sir George Watt, indicated that there was greater variety in the treatment to which jute was subjected than variety in the races grown. Endeavours have been made to obtain pure seed of all local varieties, which have been grown at the Burdwan farm for comparative tests, the most important points for elucidation being whether the quality of the fibre varies with the kind of the jute sown; whether a well grown crop on good manured soil produces better fibre than an inferior crop; how the quality and outturn of fibre is affected by thick and thin sowing; the effect produced by sowing sound and matured seed, produced from healthy vigorous plants specially sown very thinly for seed, in comparison with seed obtained from an ordinary thickly sown crop grown for fibre. In addition experiments were started to test (*a*) manures, (*b*) cutting the fibre at different stages of growth, (*c*) selection of seed, and (*d*) spacing experiments. A careful botanical examination by the Reporter on Economic Products showed that whilst there were numerous agricultural races of jute, all were included in either *Corchorus capsularis* or *C. Olitorius*. The races of the former were found to be more numerous than those of the latter and were conspicuously wanting in permanency, due perhaps to free cross-fertilization. The main differences were in the date of flowering, height of plants, vigour of growth, and colour of stalks and leaves. These experiments were also referred to the Board of Scientific Advice, and the opinion expressed was that the deterioration of fibre is very largely, if not wholly, due to fraudulent watering of the prepared fibre in order to increase its weight. There was no evidence of degeneration in the jute plants. The advisability of legislation to prevent fraudulent adulteration has been under consideration, but the proposals have not met with general approval. The Board of Agriculture considered the possibility of extending jute cultivation, the most promising tracts being the delta areas of Madras, Lower Burma and the coast of Bombay. At the instance of the Inspector General, the Madras department of agriculture has started experimental trials in the Godaveri Delta. Trials have also been started in Chhattisgarh by the Central Provinces department of agriculture. An inquiry into the retting process has

shown that the quality of fibre is harmed by the use of dirty water and also that discoloration results from retting in water containing iron. The results of all these experiments have been published in the Report of the Board of Scientific Advice and in 'Selected Papers on Inquiry into Deterioration of Jute, 1903-1904.' The investigation is now being taken up on a larger scale by the Bengal department of agriculture, who are starting jute experiment stations in several localities. The retention of Mr. Finlow's services as Jute Specialist has been recommended.

27. **Juar** (*Andropogon sorghum*).—A collection of the very numerous varieties of Juar grown in different parts of India was made in order first to afford material for a botanical examination and second to test their respective qualities. They were grown on the Bombay farms in 1903, and 50 varieties were selected as worthy of further trial. These were distributed to Government farms in the Punjab, Bengal, Madras and the Central Provinces, with the result that some promising varieties are under trial with a view to their introduction in substitution of inferior local varieties. An extended trial of the 'Dharwar' variety is in progress in the Central Provinces. The botanical examination is still in the charge of Professor Gammie at Poona. Some samples of good red varieties were sent to the Transvaal, in order to test the possibility of an export trade from India to South Africa, where red juar is largely used for the production of beer. The samples were valued at R18 per bag of 200 lbs. in South Africa.

28. **Maize.**—Trials were given in the United Provinces, Punjab, Bombay and the Central Provinces to some American maize imported by the Reverend Mr. Windsor of Sirur (Bombay). This seed did not give satisfactory results, the yield being everywhere poor. Some special varieties introduced by the Inspector General of Agriculture from America were more promising, but the sugar-corn varieties do not retain their qualities. The result of other trials tends to show that American varieties are not generally so suited to India as the indigenous stock.

29. **Soy beans** (*Glycine soja*).—Six varieties of soy beans were introduced from Japan by the Inspector General of Agriculture in 1902. These white or green seeded varieties are far superior to the black seeded varieties grown in the north of India. The trials were successful on the Siripur, Kirkee and Cawnpore farms. The beans and chaff were analysed by the Agricultural Chemist to the Government of India in order to determine their value for oil and feeding

stuff. Most of the samples were found rich in nitrogenous compounds with a very high percentage of oil. As these preliminary experiments gave promising results, a fresh supply of ten varieties was obtained from Japan in 1903, which are now under careful trial to see if they can be grown as profitably as the more common pulses. The highest percentage of oil in the beans was 24·87, whilst ten samples gave over 20 per cent., which may be compared with an average of about 17 per cent. obtained in the United States. The percentage of albuminoids in the chaff varied largely, the highest being 8·12. The chaff has undoubtedly a high feeding value.

30 **Tobacco.**—The Inspector General of Agriculture obtained from Java two varieties of tobacco known as 'Taloen' and 'Wlingi' and two true wrapper leaf varieties, 'Deli (P)' and 'Deli (D).' Four varieties known as Havanna, Spanish, Florida and Sumatra, which had been grown for some few years at Dalsingsarai (Behar) and two of the best indigenous varieties (Shamru and Peelio) of Bombay, were added to the collection, which was distributed for trial in Madras, Bombay, Bengal and Kolhapur. The trials in Madras were generally unsuccessful, but promising results are reported from Kolhapur. Havanna tobacco has successfully been introduced into general cultivation in Burma and can be grown well in Behar. Further progress is improbable until the problem of improving the methods of curing is taken up, which is a matter for an expert that demands attention. The employment of an expert in tobacco curing and a chemist for the improvement of tobacco has been recommended by the Board of Agriculture.

31. **Sweet potatoes** (*Ipomæa batatas*).—Three varieties were imported by the Inspector General of Agriculture from America These did extremely well at Poona, with the result that cuttings and tubers were distributed throughout India, together with a leaflet describing the best methods of cultivation. A collection of the indigenous varieties was also made and grown for comparison at Poona. Only a few were found to equal, and none to excel, the American varieties. Three varieties were also obtained from the West Indies, but did not prove suitable.

32. **Irrigation.**—In accordance with the instructions of the Government of India, provincial departments have started hydraulic experiments in the irrigation of crops upon the lines recommended by the Irrigation Commission. The Inspector General of Agriculture twice gave evidence before this Commission and submitted notes on the extension of

irrigation in the Bombay Presidency and protective works in the Deccan. The Bengal department has opened a farm at Cuttack for irrigation experiments in rice, which are also being carried out at other existing farms. The Punjab department has arranged in conjunction with the Irrigation Department for experiments in the best methods of irrigating wheat. The Bombay department is conducting irrigation experiments at the Sindh cotton farm. Madras has started some stations in order to study the 'duty' of water for various crops and soils. Many useful tests have also been made in that Presidency of waterlifts, aermotors, oil-engines and the like, in consequence of which several oil engines are now being worked by cultivators. These have shown that an oil-engine is a cheaper form of lift than the leather bucket with bullock-power in common use, provided that the well yields a full supply of water. An irrigation farm for pumping experiments is being started on the Hagari river in Bellary, which will include the irrigation of cotton as one of the principal experiments. The Central Provinces department has a series of irrigation experiments at its farms. The United Provinces contemplate the starting of an irrigation farm in the area watered by the Betwa canal. In this province much has been done towards the investigation of well irrigation, more particularly in testing different types of wells for use in tracts with sandy sub-soil, and in improving and cheapening the methods of making trial borings. These are matters of great importance to the well-irrigated tracts of the United Provinces and a new type of well now under trial promises to be successful. All these experiments were discussed by the Board of Agriculture (see items Nos. 23 to 27 of the Proceedings).

33. **Sericulture.**—Experiments in sericulture are in progress in several Provinces. The establishment of the large profitable silk industry of Cashmere is an instance of what can be achieved in this way. In Bengal efforts are made to induce the mulberry silk rearers to use only healthy seed examined by the microscope under the Pasteur system. An establishment is employed and classes are held at silk rearing depôts, the whole operations being under the management of the Bengal Silk Committee. A special grant was given by the Inspector General of Agriculture for the extension of this work, which is reported to have achieved some result, rearers now appreciating the necessity for healthy seed and the use of the microscope. Mulberry plantations are reported to be extending. In Assam some small experiments have been made with imported seed from France and Italy with successful results. Seed was also distributed to some rearers who obtained good

returns. Examination revealed the existence of *pebrine* and *flacherie* in the moths, so that reliance must be placed upon imported seed, until an arrangement is made for rearing healthy seed locally. A special inquiry was made by the Central Provinces department into indigenous tasar silk, Mr. Mukerjee of the Bengal department being deputed for the purpose. The decaying state of the tasar silk rearing industry was found to be mainly due to the prevalence of the *grasserie* disease, which has become widespread since the rearers have taken to using home-bred seed instead of collecting wild cocoons from the forests. Mr. Mukerjee's recommendations have been published in his report* on the subject. Some important work has been accomplished at Mr. Tata's private silk farm at Bangalore, which is in charge of a Japanese expert. The main object of this farm, which is an instance of the public spirit of the late Mr. J. N. Tata, has been to test the adaptability to India of Japanese methods of mulberry cultivation, silk worm rearing and silk reeling. The Inspector General of Agriculture, who visited the farm on several occasions, found that the results were promising. The farm has been good enough to train several men in the Japanese methods who were deputed from some provinces at the instance of the Inspector General. The Government of India have now sanctioned the establishment of a silk farm at Pusa, which will be managed on similar lines. An interesting trial was made at Bangalore to test the Japanese machinery for the reeling of tasar cocoons. With some modifications, this was successfully accomplished, silk of excellent quality being reeled. Arrangements are now being made in the Central Provinces to see if the simple Japanese reeling machines can be introduced into general use. The Bombay department also proposes to start some sericulture trials upon Japanese lines. The need for a silk expert to control these several experiments is greatly felt.

34. **Agricultural education.**—Agricultural colleges, with a three years' course of study, are maintained at Poona and Saidapet (Madras). Agricultural schools with a two years' course are established at Cawnpore, Nagpur, and Sibpur. The Inspector General of Agriculture was a member of a committee appointed to consider the course of training at Saidapet. He prepared a note strongly criticizing the existing management. The curriculum was unsuitable, the teaching staff wholly inadequate, and the practical work and management of the

* Report on an Inquiry into the State of the Tasar Silk Industry in Bengal and the Central Provinces of India by Mr. N. G. Mukerjee, M.A., M.R.A.C., F.H.A.S., Assistant Director of Agriculture, Bengal. Price R2.

farm inefficient. The Madras Government have since decided to abolish the college and to start a new one upon proper lines at Coimbatore. The Inspector General was also a member of a committee appointed to consider the arrangements for agricultural teaching at Poona. Their principal recommendations included the strengthening of the teaching staff by the appointment of European professors of agriculture and agricultural chemistry and improved arrangements for practical work. These recommendations have now been given effect to. Considerable improvement has been effected in the Cawnpore school. Trained teachers in botany, agricultural chemistry and veterinary science have been employed; an instruction farm has been opened; a hostel has been added; and the equipment of the laboratories improved. Excellent buildings, including laboratories, have been provided for the Nagpur school, but the teaching staff still requires strengthening and improving. The professorial staff at all agricultural educational institutions has hitherto been inadequate, so that their influence on agricultural improvement has been small. Their main result has been to turn out students, with some knowledge of agriculture, who have mostly been absorbed into the several branches of the Government revenue administration. One great defect of Indian agricultural teaching is the absence of suitable text books. European and American text books of the agricultural sciences are unsuitable because they deal with crops, methods of cultivation and other matters which are foreign to Indian agriculture, so that the students cannot appreciate the object lessons and illustrations given in explanation of general principles. Arrangements have consequently been made by the Inspector General of Agriculture, under which the Imperial experts will prepare Indian text books dealing with their respective sciences. The education of the rural classes, which is so closely connected with the improvement of agriculture, formed the subject of discussion at the Board of Agriculture. The Board emphasised the importance of conducting such instruction upon proper principles based upon the agricultural surroundings of the children. Proposals were subsequently made by the Inspector General of Agriculture for securing closer co-operation between the Education and Agricultural Departments in the training of rural school teachers and the preparation of suitable reading books for use in these schools.

35. **Distribution of seeds and implements.**—This is rapidly developing into an important branch of the work of the office of the Inspector General. In most field crops a large number of races,

agriculturally separate, is grown in different parts of India. Some of the races are much superior to others, and there is a wide field for the transfer of the best kinds from one tract to another. This must of course be cautiously done under proper experimental trial at the government farms. During the past four years numerous trials were arranged on several farms. In addition to the special trials recorded in the preceding paragraphs, the Inspector General distributed small quantities of seed of varieties of rice, bulrush millet, gram, oats, barley, onion, cardamom and others. Two instances may be given of successful results from this action. Several varieties of rice were sent for trial, with the result that both in Madras and Orissa, a variety known as 'Banko' from the Central Provinces gave excellent results. It is found to be suitable for high level land and to thrive with a minimum of water. Seed was distributed to cultivators and now there is a large demand for it. In Behar the 'Mozuffernagar' wheat of the United Provinces has succeeded and is rapidly ousting other varieties. Distribution on a considerable scale both to government farms and private persons has been made of seed of cotton, wheat, juar, rice, ground-nut and other crops. The amount of seed distributed approximates to 17 tons. Numerous requests for seed are received from private persons, which are met so far as is possible. The distribution of seed has brought into prominence the fact that it is difficult to introduce new crops or methods of cultivation unless the Inspector General can send to the tract trained subordinates, who can be trusted to carry out instructions. Numerous lots of seed have been sent in response to the request of foreign correspondents in the United States of America, Natal, East Africa, West Indies, Australia and Japan. The interchange between provinces of superior indigenous implements has been productive of some good results. Instances may be given of the Guzerat cotton cultivation implements, the Poona sugar boiling apparatus and the field hoe of the Deccan. Better results generally are secured by transferring indigenous implements rather than by the introduction of foreign ones, but considerable success has been achieved in Bombay and the Central Provinces in the distribution of iron ploughs and in the Central Provinces of winnowers and fodder cutters. Numerous inquiries are received from private persons for all imaginable kinds of information. These are answered as fully as possible, often involving much labour. In many cases it is evident that the labour is wasted, but the demand for information from all sides is a hopeful sign of the awakening of the country to the importance of agricultural improvement.

36. **Publications.**—Appendix C gives a list of recent publications relating to agriculture in India, including not only the work of members of the agricultural departments but important contributions by officers of other departments in India. The arrangements for publications by the imperial department have hitherto been in a very unsatisfactory state. This question was fully discussed by the Board of Agriculture, and their recommendations have now received the sanction of the Government of India. The imperial department will in future have two important publications—(1) A quarterly issue called 'The Agricultural Journal of India' containing articles on agricultural matters, intended for the information of the agriculturist and the general reader interested in agriculture; and (2) Scientific Memoirs for papers of a scientific or technical nature.

37. **Expenditure.**—The expenditure incurred in the imperial department of agriculture (apart from expenditure on buildings constructed by the Public Works Department) has been as follows:—

Section of Department.	1901-02.	1902-03.	1903-04.	1904-05.
	R	R	R	R
Inspector General	21,849	43,623	56,956	1,15,753
Pusa	...	...	50,550	1,27,833
Agricultural Chemist . . .	11,060	26,000	21,164	23,517
Cryptogamic Botanist . . .	...	18,972	18,009	21,080
Government Entomologist . .	...	...	16,246	27,230
TOTAL .	32,909	88,595	1,62,064	3,15,413

The increase shows how rapidly the department has expanded, but the provision is still inadequate to meet many important demands made upon it. In addition to the ordinary budget provisions, the Inspector General receives an annual grant for expenditure upon special investigations, improvements and the like, which he may desire to introduce. The principal objects to which this grant has been devoted in the past four years are enumerated below:—

	R
Extensions of the Manjri (Poona) farm	900
Well irrigation at Surat	1,000
Fodder reserves at Chharodi cattle farm . . .	5,500
Quarters for apprentices at Bombay farms . . .	4,270
Cotton experiments	15,000

	₹
Improvements to Nadiad farm	6,100
Irrigation scheme at Pusa	3,000
Improvement of irrigation at Nagpur farm . . .	2,840
Improvement of irrigation at Hoshangabad and Raipur farms	10,000
Silk experiments in Bengal	8,000
Distribution of manures to cultivators around Burdwan .	4,000
Tobacco curing experiments at Nadiad and tree cotton experiments at Belgaum	6,000

The power to give such provincial support is an important adjunct to the influence which the Inspector General of Agriculture can exercise over provincial schemes.

38. **Provincial Departments, Bombay.**—In the preceding portion of this report an account has been given of the principal investigations conducted both by the imperial and provincial departments of agriculture, and in the following paragraphs a short summary will be given of other work of a more general character done by each provincial department. The Bombay department is the most advanced in India, owing to the fact that for some years past it has employed some expert staff to control the work. Three additional European experts have now been appointed as Economic Botanist, Agricultural Chemist and Professor of Agriculture. The Upper subordinate establishment has also been strengthened. New experiment stations have been started; (1) Dharwar farm in the Southern Maratha Country, (2) Dhulia farm in the Khandesh District, and (3) Mirpurkhas farm in Sindh, at all of which cotton will be the principal crop. The existing farms have largely been utilized by the Inspector General for special investigations. They have also served as a good training ground for apprentices sent from Bengal, Madras and the Punjab. The Nadiad farm, which was the property of and managed by a private association, has been extended and re-organized under the guidance of the Inspector General, who makes an annual grant towards its maintenance on condition that the cropping scheme is approved by him and the farm controlled by the Bombay department. Its principal line of work is the study of tobacco cultivation. The Inspector General has also taken a lively interest in the management of the Northcote cattle farm at Chharodi, the most important improvement being provision for a reserve stock of fodder to guard against a famine year. At several farms important experiments are in progress in the manuring of cotton and other crops. At the Manjri farm the nitrogen requirements of sugarcane are being determined. Some successful trials have also been made of the

Broach type of cotton under irrigation. The Poona farm has largely been utilized for growing varieties of crops for botanical examination by the Economic Botanist. Cotton, wheat, juar, rice and tur are being worked out. The management of the Poona dairy farm has been improved. This serves as a model to the public, a training ground for students, and for experiments in the improvement of dairy breeds and in feeding and dairying operations. The Kirkee Botanical Garden has started some useful economic work in rubber, fibre plants, spices, and other plants. The Director, Mr. H. S. Lawrence, I.C.S., has controlled the department with conspicuous success.

39. **Madras.**—The permanent government farms at Bellary, Koilpatti and Samalkotta were all visited by the Inspector General. The two former are mainly devoted to experiments in tillage and manures under the control of Mr. Benson, M.R.A.C., Deputy Director. Deep tillage combined with surface interculture produced much better crops of cotton at Koilpatti during the last year's dry season than the local methods of cultivation. Some useful preliminary work has been done in testing varieties of cotton, juar and other millets. The Samalkotta farm is devoted to the study of sugarcane, mainly with the object of preventing the serious losses in the Godavari Delta caused by red rot (compare paragraph 16 of the Cryptogamic Botanist's report, page 79). This is under the control of Mr. C. A. Barber, M.A., F.L.S., Economic Botanist. The testing of varieties has resulted in the distribution of two canes (white Mauritius and striped Mauritius), the demand for which is so great that it cannot be met in full. The experiments in methods of cultivation and manuring also promise to give practical results. New experiment stations have been started for ground-nut in South Arcot and pepper in Malabar, to study the serious fungus diseases from which these crops are suffering. The work in cotton has hitherto been preliminary only, and the need for strengthening the establishment in order to take this up is clearly apparent. Some experimental work in the improvement of tobacco cultivation and curing has commenced, but real progress must await the appointment of an agricultural chemist. The Agave fibre station at Hindupur is now beginning to yield results, sisal hemp promising to prove successful in the dry stony soil. Much interest has been shown in the starting of district agricultural associations, which are guided by a strong Central Committee formed in connection with the Victoria Technical Institute of Madras.

40. **United Provinces.**—An Economic Botanist (Mr. H. M. Leake,

M.A., F.L.S.) was added to the staff. A new experiment station has been started at Orai to serve the Bundelkhand country. The Inspector General assisted in drawing up a scheme of experiments in green manuring and rotations for the Cawnpore farm. The Deputy Director (Mr. J. M. Hayman) has continued his investigations of wheat rusts (see paragraph 10 above) and the insect pests of the Cawnpore farm. The study of the wheats of the province has progressed and the crossing of varieties with the object of obtaining a suitable strain for the Bundelkhand district. The study of the local varieties of juar and poppy has been started. The investigation of the Rohilkhand processes of sugar boiling has been practically completed, and some important modifications have been recommended for the improvement of the yield both in quantity and quality.* The Economic Botanist has started the general investigation of the cottons of the province and the production of hybrids, but his time is so occupied with his administrative duties as Superintendent of the Saharanpur Gardens that he has little opportunity for research work. Proposals have been made to remove this difficulty. The distribution of good seed to cultivators has been effected on a large scale, over 4,000 maunds being dealt with. The department has been most efficiently controlled by Mr. W. H. Moreland, C.I.E., I.C.S.

41. **Bengal.**—A Deputy Director (Mr. F. Smith, B. Sc.) has been appointed, but it is impossible for him alone to control the many experiment stations and other spheres of work of the department, which suffer from inadequate control and a poor subordinate establishment. After local inspection, the Inspector General drew up a revised scheme of experiments for the principal farms. Fieldmen were also sent to demonstrate improved methods of cultivation. A new farm has been started at Cuttack, mainly for experiments in the irrigation of rice. Another farm has also been started at Chittagong. The scientific inquiry into indigo and jute has been noticed in paragraphs 25 and 26 above. The trials of cotton have generally failed, but the season was unfavourable. An interesting attempt is being made to introduce into general use around Burdwan a manure for rice consisting of saltpetre and bonemeal. Tobacco experiments are in progress at Rangpur. An important provincial agricultural association has been started at Calcutta and some district associations have been formed under it.

* Improvements in native methods of sugar manufacture, by Mr. Syed Muhammad Hadi, M.R.A.C. Bulletin No. 19 of 1905, United Provinces Department of Agriculture.

42. **Punjab.**—The provincial department of agriculture is in its infancy. An experiment station was started at Lyallpur in 1901, for which the Inspector General drew up a detailed working scheme. There are special opportunities here for agricultural work, for this farm is situated in the Chenab Canal Colony, where the new settlers have no stereotyped system of cultivation and are willing to assimilate any improvements. A second farm has been started at Sargodha in the Jhelum Canal Colony mainly with the object of providing good seed for the colonists. An expert agriculturist (Mr. S. Milligan, B.Sc.) has been appointed Deputy Director. The promising results of the trials of exotic cottons have already been noticed (paragraph 18 above). Tests of many varieties of wheat are in progress to determine the most suitable varieties for the Colonies.

43. **Central Provinces.**—Appointments of Deputy Director and Agricultural Chemist have been created, but the department will still be undermanned. New experimental farms have been started at Hoshangabad (principally for wheat) and at Raipur (principally for rice), whilst the Nagpur farm will be mainly devoted to cotton and juar. With his head-quarters at Nagpur, the Inspector General has been able to watch carefully the work in the Central Provinces. The working schemes of all the farms were revised by him. The cotton experiments have not progressed much owing to the want of supervision by a botanist. The campaigns against locusts and grasshoppers have already been noticed (paragraphs 13 and 14 above). A special inquiry into sugarcane cultivation is in progress. The study of wheats and the breeding of new varieties for rust resistance has advanced. The distribution and sale of implements is increasing, more particularly of fodder cutters, winnowers and iron-ploughs. Much useful work has been done by demonstration farms and peripatetic work, for which there is much scope owing to the inferior methods of cultivation practised in the backward parts. Demonstrations of improved methods of cultivation are producing some results; the steeping of juar seed for the eradication of smut is coming into general use; the embanking of wheat land is spreading; and several improved varieties of crops have been introduced. The district agricultural associations continue to be an important agency in the spread of these and similar improvements. The vernacular monthly Agricultural Magazine maintains its popularity with a circulation of nearly two thousand copies.

44. **Assam.**—The provincial department maintains an experiment station at Shillong, principally for temperate fruits and vegetables, and

a second at Wahjain, principally for tropical fruits and plants. Some superior varieties of potatoes have been introduced into general cultivation. Methods of spraying for the prevention of the potato blight are under trial. The sericulture experiments have already been noticed in paragraph 33 above. A trial of American nitrogen-fixing culture on peas failed to give any result.

45. **Burma.**—A department of agriculture has not yet been organized in Burma. The Inspector General has submitted a scheme framed after a tour of inspection. Some successful results have been obtained by the distribution of seeds and plants. Potatoes, strawberries, and other fruits have been introduced into the Hill States. Havanna tobacco has been established in general cultivation in the Irrawaddy delta. Ground-nut is also being generally adopted.

46. **Native States.**—Apart from the departments of the provincial governments, some Native States maintain separate departments of agriculture, with which the Inspector General has no direct concern. He has, however, been in frequent communication with the departments of the Baroda and Mysore States. There has been no opportunity to visit Baroda, but some assistance has been given in the supply of seeds for experimental trials, in the training of assistants and in advice on several questions referred to him. Several visits have been made to Bangalore, which is the head-quarters of the department maintained by the progressive State of Mysore. An account of the work has been kindly furnished by Dr. A. Lehmann, Ph.D., Agricultural Chemist, which is printed as Appendix C of this report. Excellent laboratories have been constructed, and an experimental farm has now been started. Sanction has also recently been given to the appointment of a second scientific officer as Entomologist and Mycologist. Much attention has been given to coffee, which is the principal crop of Mysore. Investigation has been made into the soils, methods of cultivation, manuring and the like; suggestions have been made for improvement, but without a coffee experiment station it is difficult to make proper tests. In the laboratory efforts have been made to discover a test for quality in coffee, which seems to bear a close relation to the specific gravity. Sugarcane cultivation and the local processes of making jaggery have been examined; recommendations have been made for lessening the considerable loss that undoubtedly occurs in the local method of sugar boiling. Tests have been made of a large number of foreign grasses with the object of improving the fodder supply, but these have repeated the common experience

that the indigenous plants of India are more suitable than exotics. Much good has resulted from the analysis of samples of fertilizers, which have been shown to vary enormously in composition, the lesson of which is that they should only be purchased under a guarantee of quality. In the investigation of the important fungus diseases and insect pests of coffee, assistance has been given by the Cryptogamic Botanist and the Entomologist of the Imperial Department (See Parts IV and V of this report). Dr. Butler has been obliged to abandon the investigation of the obscure ' spike ' disease of sandal-wood, because it would occupy the whole time of a mycologist for a long period. An annual report is published by the Agricutural Chemist of the Mysore State giving an account of each year's work.

47. **Proposals for future expansion of the departments.**—In the preceding paragraphs an account has been given of the working of the existing departments, and this report may suitably conclude with an outline of the proposals for their future expansion. In March last Government announced that they had decided to make an additional annual grant of R20 lakhs (£133,000) for expenditure upon agricultural research, education and improvement. This grant will permit of a large expansion in the work of the departments. Proposals were framed by the Inspector General suggesting the general lines of expansion. These have been considered by Local Governments, who have prepared the provincial schemes. These naturally vary in order to suit the local requirements, but follow certain general lines. In the first place it is intended to provide an experiment station in each important distinct agricultural tract. The staff of specialists of each important province will ultimately be strengthened so as to include one or more Superintendents of Farms or Deputy Directors (expert agriculturists) as they have hitherto been named, an Agricultural Chemist, Economic Botanist, Mycologist and Entomologist. A further improvement, upon which great immediate stress is laid, is the establishment in each important province of an Agricultural College with a competent teaching staff and fully equipped laboratories. This will be located on the principal experimental and instruction farm which will also be the Central Research Station The expert staff mentioned above will for the present be responsible for the teaching in addition to their research work, with the help of competent native assistant professors and a full subordinate staff. The course of instruction will last three years, after which it is hoped that a few of the best students will proceed to Pusa for a further post-graduate course

of two years in order to fit them to fill the higher appointments. It is hoped also to improve the means of introducing the results of research work into general agricultural practice. Temporary demonstration plots will be started; the formation of district agricultural associations will be encouraged; agricultural shows will be supported; the distribution of improved seed, implements and manures will be extended; popular publications in the vernacular will be encouraged. In order to control a large provincial department upon this scale, it has been decided to appoint a separate Director of Agriculture, who will be responsible for its general administration and discipline. As regards the imperial department, the first proposal is to appoint supernumeraries to each specialist, who after the completion of their college education in England will be posted to Pusa in order to undergo a further training under Indian conditions. They will be absorbed into the regular cadre of the provincial departments as vacancies occur. It is thus hoped to lessen the existing difficulties of recruiting in England suitable candidates of experience. It is also proposed to strengthen the imperial staff by the employment of specialists who can devote their whole time to the investigation of important special problems. The additional specialists at present proposed include a *Cotton Expert* to guide and correlate the experiments for the improvement of Indian cotton; a *Wheat Expert*, to investigate the special problems of the wheat crop, including the improvement of the milling and baking qualities of wheats grown for export; a *Sugar Expert* to investigate the problems of sugarcane cultivation; a *Tobacco Expert* to introduce improved methods of tobacco cultivation and curing; and a *Fruit Expert* to improve the fruit cultivation and the methods of packing and grading in the important fruit-growing temperate zone of north-west India. Such are the outlines of the general scheme for the expansion of the imperial and provincial departments, which has become possible with the increased grant for expenditure. This scheme has yet to receive the sanction of the Secretary of State, and must necessarily take some years before it can be introduced in its entirety. When it is completed, the Departments of Agriculture will for the first time be placed in a proper position to deal with the problems of India's greatest industry, which supports three-fourths of her population.

F. G. SLY, I.C.S.,
Officiating Inspector General of Agriculture in India.

Dated the 9th September, 1905.

Part II.

ANNUAL REPORT OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA, FOR THE YEAR ENDING THE 30TH JUNE 1905.

I. GENERAL.

1. **History.**—The Government Estate of Pusa covering an area of 1,358 acres is situated in the district of Darbhanga, Bengal, 6 miles from the Waini station of the Tirhut State Railway. It was first acquired by Government in the year 1796, and was used as a Stud Farm until 1874. Horse breeding operations were then abandoned, and a part of the property was utilised as an experimental farm, special attention being devoted to the growth and curing of tobacco. In 1877 it was leased to Messrs. Begg, Dunlop & Co. of Calcutta as a tobacco estate and factory; they abandoned the enterprise in 1897, when the Bengal Government again assumed charge of the property. In 1902 a scheme was prepared for utilizing the estate as a cattle breeding and dairy farm, to which were added proposals for establishing an Agricultural Research Station and College. It was apparent that an undertaking of this magnitude concerned not only the province of Bengal but the whole of India, and it was eventually settled that the management should be placed under Imperial control. The munificent donation of £30,000 by Mr. Henry Phipps, an American citizen, placed at that time in the hands of His Excellency the Viceroy, assisted greatly to these conclusions, and the greater portion of this sum (£25,000), was set aside for the erection of the Institute and Laboratories. The scheme as finally approved by the Government of India was sanctioned by the Secretary of State, and on the 26th of December, 1903, the property was formally handed over by the Bengal Government to the Government of India.

2. On 1st January, 1904, Mr. Mollison, the Inspector General of Agriculture, brought his camp to Pusa, and immediately began the preliminary work of clearing and levelling. Farm buildings were commenced, work cattle purchased, and some of the land brought under cultivation. On the 1st April, 1904, I had the honour to enter upon my duties. Since then my principal duty has been to continue the work of laying out the estate. This has been much facilitated by the

co-operation of the Bengal Government, the Lieutenant-Governor, Sir Andrew Fraser, making a visit of three days in February, 1904, to pass the necessary orders concerning the disposition of the property, and the position which the Bengal Government would henceforth hold in relation to the Institute.

3. **Objects and aims.**—The scheme as sanctioned by the Secretary of State comprises:—

(1) An Experimental Farm.
(2) An Economic Botanical Garden.
(3) A Research Institute.
(4) An Agricultural College.
(5) A Cattle Breeding Farm.

The farm will comprise some 300 acres of land under cultivation in the immediate charge of an expert agriculturist from England. The chief functions of the farm will be to afford a training ground for the students of the college, a means to the scientific experts of working out on a practical scale the many problems which await their investigations, and a distributing centre for improved seeds and plants. The Economic Botanical Gardens in charge of the Economic Botanist will be for the use of the scientific officers and the students, and will contain as far as possible a complete collection of the economic plants of India. The Research Institute will have spacious laboratories fitted with the best apparatus for scientific research, and will also contain a library of the most important works and periodicals allied to agriculture, as well as a museum and Therbarium. he publication of the work done at Pusa under the control of an Editorial Committee of the staff, is to be one of the most important undertakings of the institute, and it is intended that a central bureau of reliable information on agricultural subjects should thus be created for the whole of India. The College for the training of students will be attached to the institute and a hostel is being built to accommodate at first some 70 students. It is to be of the University type, for post-graduate candidates, and will be fed by the agricultural colleges of the provinces. In the latter, students will undergo a course of three years' training in general scientific and practical work, and the most successful candidates will pass out of the provincial college into Pusa, there to complete another two years of specialised training. By this method it is expected that it will be possible to supply for the agricultural departments in India scientific men of a high order, who, it is hoped, will be competent to fill the highest posts in professorial work, or become reliable specialists for

original research work, and thus supply one of the greatest needs of the country. The cattle breeding farm is composed of two parts; one in which local cattle of the best type will be bred for the supply of bulls to Bengal and Behar, and the other in which various approved herds will be kept for acclimatisation and use in these districts. Some 400 acres have been set aside for grazing.

4. **Board of Agriculture.**—On 6th January, 1905, the members of the Board of Agriculture appointed under Government of India Resolution No. 24—14-1 of the 20th September, 1904, met for the first time under the presidency of Mr. F. G. Sly, I.C.S., Officiating Inspector General of Agriculture, and were accommodated under canvas. The number of members present was 31 and the proceedings lasted five days.

5. **General features of year's work.**—The general features of the work of the past year have been the erection of buildings for the scientific staff and their establishments, the clearing and breaking up of lands for the use of the experimental farm, and the general reclamation of the whole estate, most of which since the close of the stud farm in 1874 had been allowed to lapse to jungle.

II. BUILDINGS AND OTHER WORKS.

6. **Public Works Department.**—Building operations under the Public Works Department commenced in the month of November last, and for a time made rapid progress, but in the months of February and March the work slackened off, which was explained as being due to the department being undermanned. The operations were then constituted an independent charge under Mr. Arnott as Superintendent of Works, and since his arrival, operations have progressed with renewed activity. Residences for the European officers and quarters for the subordinate staff are under construction, several having been already completed and occupied. The main college and research building, known as the Phipps' Laboratory, has also been commenced. The foundation stone was laid on the 1st April, 1905, by His Excellency Lord Curzon, Viceroy and Governor General of India, a large number of European and Indian gentlemen attending the ceremony at the invitation of Sir Andrew Fraser, the Lieutenant-Governor of Bengal. Important speeches explaining the nature and scope of the institute were made by His Excellency the Viceroy and Sir Denzil Ibbetson, K.C.S.I., Member of Council. Owing to the complicated nature of the design, it is not expected that the building will be completed under another two years

and with the time it will take to supply the fittings it is calculated that it will not be ready for occupation before November, 1907.

7. **Departmental work.**—Among the buildings, the construction of which was undertaken departmentally, the farm buildings with machinery were finished in the month of October last at a total cost of ₹60,350. In order to enable research work to commence, temporary laboratories are being erected, and should be completed by the month of October of the present year. An insectary for the use of the Entomologist, and a potculture house for pot experiments, are under construction, and will be soon ready. Sanction has been given for the building of houses for sericulture, and the accommodation of a Japanese silk expert.

8. The irrigation scheme sanctioned by the Government of India for the supply of water to the estate is near completion, and will be of the greatest utility for the experimental work.

III. THE FARM.

9. **Cultivation.**—Mr. E. Shearer, M.A., B.Sc., entered on his duties on the 19th November, 1904, as Agriculturist to the Institute. The work of the past year has been mainly the removal of old and useless buildings, the cutting of trees and jungle that had grown over the property, and the bringing into cultivation of the portion of the estate set aside for the farm. The total area brought under cultivation is 350 acres. Beyond the growing of varieties of crops for fodder and for the purpose of getting the land into normal culture, no experiments that can correctly bear that name have been carried out, if we except the growth of many varieties of cottons to which reference will be made later. Land, which has been abandoned to grass and jungle for a long period of time, cannot at once supply those conditions of uniformity and normality, which are absolutely required for the purpose of reliable and satisfactory agricultural tests. Indeed it must take time and practical experience, before we can ascertain whether the required conditions of soil have been reached. For these reasons the land of the farm can supply at present the requirements of no strict experiments as such, and it will take time before the agriculturist or myself will be able to say that it is fit for tests in which conditions of uniformity and normality in the soil are essential. I would, therefore, strongly deprecate the farm being pressed to do experiments, which at this moment cannot be carried out under the conditions required by the exigencies of scientific research. I have felt constrained to make these

remarks, as there appears a very widespread idea that the Pusa farm is in a position to carry out most of the agricultural tests common to experimental farms which are in full working order. To work on this assumption will not only cause disappointment, but owing to the varietal nature of the work such a proposition would entail, the lands would have to be prematurely sub-divided into small plots and areas, which would greatly hamper the initial work we have in hand, and prevent the realization of uniformity in the soil which can only be acquired by the cropping over large areas with only one crop at a time. These remarks do not refer to most of the problems in Entomology, Mycology and Economic Botany, and the initial investigations that are required to be made by the Agricultural Chemist. They can be taken in hand at once. It is only where the conditions of soil are required to be uniform, normal and constant, such as in comparative manuring tests, comparative modes of cultivation, and the like that these remarks apply.

10. **Cotton experiments.**—I have made an exception in the case of cotton to my statement that no experimental work has been carried out on the farm in the past year. Nearly all known varieties, both indigenous and exotic, have been given a trial. These were divided into two main heads (1) tree cottons, and (2) annual cottons. We can dispense for the present with the tree cottons, which are perennials, and take at least two to three years to establish themselves, so that any remarks on the results so far obtained would be premature. Regarding annual cottons the case is different, and although the results are by no means conclusive, we are able to forecast the probabilities of success and the lines on which the experiments should in future be conducted. To aid us in our opinions we have besides the experiments carried on at Pusa, those carried out by the planters in Behar over an area of some 3,000 acres. The conclusions arrived at by the planters themselves are that the growing of cotton with them has been a complete failure, and that the soil and the climate of Behar are unsuitable for its growth. From an industrial and commercial aspect I can but agree with this statement, as far as the present time is concerned. But from an experimental point of view, I think that it is possible and even probable that a cotton may be bred to suit the Behar climate and the requirements of the home market. This necessarily implies that we have no cotton at present that suits, and that it will be necessary to breed and acclimatise a plant for this purpose. By this I indicate the lines upon which, in my opinion, the experiments should be

conducted. It is essentially a problem for the Economic Botanist to carry out, but which should be worked out at Pusa. It has generally been considered that an early flowering variety such as the American is the best, but I am entirely of the opposite opinion, and think that a late flowering variety will be found more adaptable. The reason for this is that if an early variety is sown at the only two normal seasonal periods of sowing, namely, June or October, the flowers and fruit from the first are either entirely spoilt by the heavy rains of the monsoon or the cold in the succeeding months, while plants from the second are too young to withstand the cold of the winter months. The only alternative which seems to present itself is to have a late flowering variety, which sown in June, will yield in the following March and April. This in fact is the only kind of cotton plant which is grown in Behar by the native cultivator. Its selection is doubtless the result of accumulated experience, for though the cotton is very inferior in quality, it is the only variety that will flourish in Behar, and is remarkably free from pests and disease. It, therefore, seems to me that in the face of the results obtained during the past season, this plant should form the foundation of our future work. Now that the Economic Botanist has arrived in the country, the whole question of cottons will be duly considered by him, and experiments laid out in accordance with his views.

11. **Cattle farm.**—I have to report but slow progress under this head. Forty-five cows and one bull of local breed were purchased for the farm by the Civil Veterinary Department, Bengal. Of these 25 were rejected by the Inspector General of Civil Veterinary Department in January last. We have, therefore, only 20 cows and 1 bull left, and are awaiting further purchases by the Superintendent, Civil Veterinary Department, Bengal. When the cattle first arrived at Pusa, they were in poor condition, and they did not improve with the abnormal cold which obtained in January and February. Since then a liberal ration of concentrated food has been prescribed, and the condition of the cattle at present is all that can be desired. The cost of this ration has added considerably to the outlay under this head, but it is expected that with the introduction of a more economical basis of feeding, expenditure will be reduced.

12. Fourteen Montgomery cows and one bull were introduced into the farm last year from the Punjab, with a view of testing their adaptability to these districts. One cow died and the rest are doing well, but their milking powers are not as great as we were led to anticipate,

the yield being from 5 to 8 seers per day, according to the cow. These cattle did not thrive well at first, but now appear to be acclimatised, and it is possible that an increase in milk may be expected from their next calf.

13. Some 400 acres of pasture have been reserved for the grazing of the cattle. A certain area of this has been put down to artificial pasture. Two of the old stables of the estate have been fitted up for the housing of the different herds and will accommodate 200 head of cattle.

IV. CHEMISTRY.

14. No work has been started yet under this branch, and Dr. J. W. Leather, Ph.D., F.I.C., F.C.S., at present Agricultural Chemist to the Government of India, the officer to be in charge of this section, is not expected before November. In the meantime temporary laboratories and a pot-culture house are being erected for his use, and will be ready by the date of his arrival, so that he need lose no time in commencing the work of many of the important problems which await his investigation.

V. BOTANY.

15. Mr. A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., the Economic Botanist, has arrived in India, and will be able to commence his work here at once. Besides the various problems which await his attention with agricultural crops, the orchards and botanical gardens will be placed in his charge. Fruit trees of many varieties have already been collected and planted, and the botanical gardens are being laid out. It is proposed that besides making these to a limited extent ornamental, they should also be planted with as complete a collection of economic trees and plants as it is possible to collect. These will afford not only a means of studying on the spot the origins of most economic products, but will provide a training ground for the students, and the means of extended investigation for the scientist.

VI. ENTOMOLOGY.

16. Mr. H. Maxwell Lefroy, M.A., F.E.S., F.Z.S., the Entomologist appointed to be in charge of this department, took up his head-quarters at Pusa on 1st May, 1905. He had previously been at Pusa during the year and many of the crops have been treated for various pests, the results of which will be the subject of a separate

report from that officer. An insectary has been built and will very shortly be ready for his use.

VII. MYCOLOGY.

17. Dr. E. J. Butler, M.B., F.L.S., at present Cryptogamic Botanist to the Government of India, who is the officer to be appointed to this branch, has not yet removed his head-quarters to Pusa, but plans of his experiments have been received which are being duly carried out. Temporary laboratories are also in process of construction for his use. Owing to the injury which might result to the farm crops from the contagion or infection caught from diseased plants under investigation, it has been thought proper to isolate the experiments in the case of diseases which have a tendency to spread, and for this purpose a separate and isolated area has been reserved.

VIII. BACTERIOLOGY.

18. Mr. C. J. Bergtheil, the officer of this department, is at present on deputation to the Bengal Government for the carrying out of experiments in indigo manufacture. Facilities are however being given him here to initiate investigations appertaining to his branch. The bacteriological investigation of soil and manures will commence as soon as circumstances admit, and preparations are being made for experiments on the effects of nodule bacilli on the soils of Pusa.

IX. WEATHER.

19. The total amount of rain that fell in Pusa last season amounted to 45 inches, which may be taken as normal, but in many other respects the character of the weather was abnormal. The rains commenced late, and the quantities precipitated were small, but this shortness was made up in August by heavy falls, which injured many of the crops. On the other hand, the unusual late rains in October secured a very fair outturn of cold weather crops. In the end of January and beginning of February, cold weather of unprecedented severity was experienced, which damaged a number of crops, notably tobacco, linseed and sweet potatoes. With the exception of the rainfall, we have been unable up to date to take meteorological observations, but the instruments for this purpose have been received from the Meteorological office, and as soon as the observatory to hold them is ready, observations will be made in due course.

X. ACCOUNTS.

20. The total departmental expenditure incurred in the past year amounted to ₹1,26,575, the principal items being ₹15,750 for pay of gazetted officers, ₹15,000 for irrigation scheme, ₹30,000 for clearing and arable cultivation, and ₹37,000 for buildings and machinery.

B. COVENTRY,
Director and Principal,
Agricultural Research Institute, Pusa.

Part III.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST TO THE GOVERNMENT OF INDIA FOR THE YEAR 1904-05.

I have the honour to submit my report on the work of this department for the year ending June the 30th, 1905. Included in it are, however, brief references to work of previous years, as directed in your letter No. 846—4-2, dated the 6th July, 1905.

2. I held charge during the whole of the year.

3. **Tours.**—I made the following tours :—

August 2nd to 15th, 1904.—I visited Poona and Bombay principally to inspect the work which was being conducted by Mr. Price, one of the Assistants in this Laboratory, on the purification of sewage. I also visited the Matunga Leper Asylum, Bombay, where Mr. Carkeet James, Sanitary Engineer to the Municipality, showed the further development of his most useful sewage experiments. I was also able to meet the Director of Agriculture, Bombay, to discuss the work generally that was being done by this department in conjunction with his.

January 2nd to 22nd, 1905.—This tour was devoted principally to attendance at the meeting of the Board of Agriculture at Pusa, and a general consideration of the work of this office with Mr. Sly. A good deal of time was also devoted on this occasion to working out details for the publication of the Agricultural Journal and Memoirs. For the same purpose I visited Calcutta in company with Dr. Butler and Mr. Lefroy. In this month I also visited Benares to see some new chemical laboratories that have been built for the Central Hindu College.

February 15th to 19th, 1905.—I met Mr. Moreland, Director of Agriculture, United Provinces, at Aligarh on this occasion, to discuss with him the possibility of employing gypsum for *Usar* land on an extended scale. The *Usar* area at Gursikran was visited as also the dairy farm at the Cherat *Usar*.

March 29th to April 16th, 1905.—Pusa was visited on the occasion of the ceremony of laying the foundation stone. The arrangements for the Agricultural Journal, the library and the temporary laboratories at Pusa were brought under consideration by Mr. Sly. After

leaving Pusa I visited Pemberandah and discussed with Mr. R. S. Finlow the experiments which would be most suitable in relation to the jute enquiry. Thereafter I visited Mozafferpore and Saran in company with Mr. Nunn, Assistant Commissioner of the Salt Department, to inspect saltpetre factories and refineries.

May 7th to 10th, 1905.—This period was devoted to an examination of the methods used in saltpetre refineries at Farrukhabad, when Mr. Buckley, Assistant Commissioner of the Salt Department, accompanied me.

June 12th to 17th, 1905.—A brief visit to Cawnpore at this time was necessitated in order to obtain information as to the amount of water in the soil at the close of the hot weather.

Mr. B. B. Price, one of the Assistants, was deputed to Poona from July 22nd to October 2nd, 1904, to carry out a set of daily analyses of the sewage in the septic tank.

Mr. Price was also deputed to the Central Provinces from December 6th to February 5th to assist in the sugarcane experiments instituted by the Director of Agriculture. He then proceeded to Pusa, and analysed the sugarcane juice there on behalf of the Cryptogamic Botanist to the Government of India.

4. **Analysis.**—The nature of the work carried on in this department may be roughly divided under two heads, namely, the analysis of agricultural materials for Local Governments, and investigations of a special nature.

The following list will illustrate the nature of the analytical work :—

Soils	88
Atmospheric dust	60
Waters	97
Manures	92
Salt earths and salts	74
Feeding stuffs	297
Sugars	65
Insecticides	1
Cassava starch	4
Jute	9
Crude rubbers	15
Timber	1
Paper	14
Coffee	1
Butter	3
	821

5. Among investigations which have been in progress the following deserve reference.

6. **Soils.**—A very large number of soils have been examined since this chemical laboratory was fitted up in 1895. At first the examination extended only to the chief ingredients. No precise information existed regarding even the main chemical features of Indian soils, and attention was devoted, therefore, in the first instance to the determination of the amount of the chief constituents in some of the better defined soils, such as the Indo-Gangetic and other alluvial soil, the black cotton soils, laterite, etc. Space does not admit in this report of a detailed reference to this work. Of these soils the Indo-Gangetic alluvium and the *Regur* vary in composition only within comparatively narrow limits, whilst in most other classes the variation is considerably greater. The work was published as Agricultural Ledger No. 2 of 1898.

7. **Sampling soils.**—The most suitable method of selecting samples of soils was taken up in 1901. The method very commonly adopted in England is to take a portion of earth from either one or at most a very limited number of places in the field which it is desired to subject to chemical analysis. The value of such a specimen for the purpose in view depends entirely on whether the field is really uniform or not. Such a condition is obviously frequently not the case, and it appears only reasonable that in order to secure a truly representative specimen, portions should be taken from a number of places in the field. Even when this is done the difference between two samples is quite large enough. The results of this investigation were published before the London Chemical Society in 1902 (Trans. Vol. 81).

8. **Available plant food in soils.**—During later years attention has been given more particularly to the estimation of that part of the plant food in soils which may be considered readily available to plants. The methods suitable for this purpose which are at present known, are limited and are admittedly imperfect, and the more accurate estimation of this readily available plant food is perhaps one of the most urgent desiderata of the agricultural chemical laboratory. Considering the chief items involved it may be said that it will pay to employ *nitrogenous* manure on all soils situated in the plains; and even in hill soils, so far as I have acquaintance with them, the same rule is more commonly applicable than I at one time thought.

Two other important ingredients are *potash* and *phosphates*. For the estimation of the amount of the readily available quantity of either of

these, the only method which can be considered at all suitable for the purpose is that of Dyer, and it has been applied in this laboratory to a considerable number of soils. It is an empirical method, and in order to check its indications, cultivations have been carried out in a small pot-culture house attached to the laboratory. The number of cultivations has only been small up to the present, and the house is not well suited to the work, but there seems every reason to expect that Dyer's method will prove itself generally applicable to the purpose. At Pusa it will be possible to push this department more energetically than has been possible here.

Lime is another constituent of soils which is required not only by the ordinary crops, but also usually to maintain the soil in a sufficiently basic condition for the healthy growth of bacteria, especially those which produce nitrate. All soils contain lime in one or another form of chemical combination, but these cannot all be considered as equally available to plants. The amount of calcium carbonate is perhaps the best indication we possess at present of the relative value of lime from this point of view, and its quantity varies in soils very greatly indeed. It is intended to test this matter by means of pot-cultures in the near future

The quantity of *sulphate* in Indian soils seems to vary more than in Europe, or at least it often falls to very small proportions, so small indeed that the adoption of special means has been frequently necessary in order to determine the amount present. There is no information as to how much sulphate a soil should possess for high fertility. It is probably only a very small quantity, but the intention is to include this subject also in the list of experiments.

9. **Usar.**—The nature of *Usar* land has been studied up to a certain point. The quantities of the pernicious saline ingredients are now known. These are usually sodium carbonate, bicarbonate or silicate, sulphate and chloride. Occasionally magnesium sulphate or chloride is also present. The quantities of these salts vary within considerable limits. If the amount be expressed as a percentage in the upper 6″ or 12″ of soil, there is not usually more than 1 or 2 per cent. and commonly much less than this. These salts are, however, generally concentrated at the surface of the soil, so that by scraping this off, much higher proportions will be found in the specimen. The effect of these salts on the soil and on the plant differs. Sodium carbonate causes an entire change in the physical state of the land, and natural drainage becomes impossible. The corrosive action of this salt on the cuticle

of the plant root is also so serious that a very small amount, such as ·1 per cent., suffices to prevent vegetation altogether. The other salts do not usually deleteriously affect the physical state of the soil, and plants can struggle in the presence of ·1 or ·2 per cent. of either the sulphate or chloride. The cause of their presence is either that the sodium carbonate has rendered the soil almost impervious to water and stopped drainage, or that the rainfall is so light that there is not sufficient water to admit of any real drainage. Broadly speaking the former is the common cause in the United Provinces, and the latter in the western districts of the Punjab. Detailed information regarding the *Usar* in the United Provinces, Punjab and Bombay Presidency was published in Agricultural Ledger No. 13 of 1897. In addition a series of samples from the Madura district, in the Madras Presidency, have been reported on.

10. The actual reclamation of *Usar* land has not fallen within the province of my work. The only methods for this, which are at all feasible, are good cultivation coupled with heavy manuring, and the application of gypsum. Drainage systems have failed so far, because the water carries earth with it and rapidly stops up the pipes. Gypsum is so expensive at present that considerations of cost prevent the general application of this agent on really bad *Usar* land. The quantity required per acre would naturally vary, but would frequently amount to 100 or 150 maunds per acre, costing R1 per maund. At the same time I believe that it *would* pay to apply gypsum in fields, which though affected by *Reh*, are not infertile. Small quantities of the finely ground mineral applied to barren patches would not entail the great initial expense that the reclamation of entirely bad *Usar* would do.

11. **The amount of combined nitrogen in rain and dew.**—The *rain water* collected at Dehra and at Cawnpore has been examined over a period of twelve months and a record of the amount of ammonia and nitrate in it kept. The quantities found are set out in the subjoined statement:—

	Rainfall.	Nitrogen—lbs., per acre.		Total.
	Inches.	As ammonia	As nitrate.	
Dehra Dun	87·45	2·178	1·391	3·596
Cawnpore	49·36	2·482	·768	3·250

There is nothing novel or remarkable in these figures, and indeed the work was only undertaken in order to add to the evidence which already exists tending to show that the amount of such combined nitrogen which is brought into the surface soil with the rain is very nominal compared with that required by crops. It may be safely stated that the quantity is not more than 5 lbs. per acre per annum in all parts of the world.

12. Although the amount of ammonia and nitrate in the *dew* is generally much greater per unit volume than that in the rain, and was from 1 to 2 parts of "ammonia" nitrogen and a similar quantity of "nitric" nitrogen per 1,000,000 (million), the actual amount of dew precipitated is so small that when the figures are expressed as lbs. of nitrogen per acre, it becomes apparent how little this source of nitrogenous plant food can affect the question of the supply in the field. During last cold weather ·055 lb. of "ammonia," nitrogen and ·056 lb. of "nitric" nitrogen per acre were found in the dew at Cawnpore. A point of interest is the fact that the amount of nitrate was relatively higher in the dew than in the rain; it usually equalled and sometimes exceeded the ammonia, whereas rain water rarely contains so high a proportion of "nitric" as of "ammonia" nitrogen, and usually the latter is considerably the greater. On the assumption that the ammonia in the atmosphere is derived from decaying vegetation, and might be thus expected to be in greater amount near the earth, whilst the nitric acid is formed by electrical discharges in the higher strata of the air, one would have expected rather the reverse result, for the dew precipitation is formed near the earth's surface, that is, in the region where the ammonia is supposed to be in comparative excess and the nitric acid if anything in deficiency.

13. During the hot weather of last year the *dust* which collected at Cawnpore almost daily on the large rain gauge, was removed carefully with a camel hair brush and a little distilled water, and weighed. The total amount found was (approximately) 28 grammes, the greater part of which settles at night. Considered from the point of view of addition of nitrogenous matter to the soil, this quantity is not great; the amount of dust per acre amounts to only ·61 lb., and would not contain more than ·1 per cent. or ·00061 lb. of nitrogen, unless indeed it collected very considerable amounts of ammonia from the air, which appears impossible. Another point which I noticed in relation to this atmospheric dust was the irregularity with which it appeared in the rain water in the early stages of the monsoon at Dehra.

The first rainfall was very dirty as is usually the case. Then followed a period of clear atmosphere and rain water free from dust, but after this the rain water again became contaminated with dust without either any serious break in the rains or dust haze appearing in the atmosphere.

14. **The drainage water at Cawnpore.**—The last monsoon provided the first set of samples of drainage water from the gauges which were constructed at the Cawnpore farm in 1903. Percolation occurred in 1903 and was measured; No. 1 gauge yielded 11·12″ and No. 3 11·97″, but the water was not analysed. During 1904 a record (excepting for a period of ten days when the collecting vessels were under repair) of the amount of drainage was maintained. It is estimated that of 43·3″ of rain which fell during the monsoon, 5″ went to make up the loss which the soil sustained during the dry weather; 4″ ran off the surface during an exceptionally heavy fall on September 9th, but all the rest soaked into the land. In July an interruption occurred in the measurements, and a correction has to be inserted in both rainfall and drainage. Thus of about 34·3″ which remained, 25·7″ is believed to have percolated, leaving less than 9″ for evaporation during the monsoon. It is also to be noted that the amount of percolation was the same from the 3-foot gauge as from the 6-foot one, excepting on one occasion when a very heavy fall occurred.

It is proposed to construct similar gauges at Pusa, and it is certain that very interesting information will be obtained from these and the Cawnpore gauges. Among other items to be held in view are the actual velocity of percolation; the effect of one stratum on the percolation of another, such as an underlying bed of sand or clay; the effect of vegetation; the amount of evaporation during the dry and wet seasons.

15. **The nitrate in the drainage water.**—Samples of the drainage water from both gauges were kept and mixed once a fortnight in aliquot proportions of daily quantity. In these the amount of ammonia and nitrate was determined, and from these analyses the quantities per 1,000,000 (million) of water and per acre are readily calculated. The drainage was similar to that obtained at Rothamsted, in that the amount of ammonia was only nominal whilst that of nitrate was very large. A very small amount of percolate occurs throughout the dry season, but this contains only a small quantity of nitrate; in fact this constituent disappears at times. Then with the advent of the monsoon and recommencement of percolation, the quantity of nitrate rises very rapidly.

For instance, the first percolate of any consequence from the 6-foot gauge, that which followed the first ·004", contained 13·4 parts of nitric nitrogen per 1,000,000, and the corresponding figure from the 3-foot gauge was 22 parts, so that there seems to be a thin layer of water in the soil of the under surface of the gauge containing but little nitrate. The concentration of nitrate rose to a maximum of 30 parts of nitrogen per 1,000,000 (million) in the 6-foot gauge and to a maximum of 23·5 parts in the 3-foot gauge. These quantities, though large, are not greater than has been found at Rothamsted.

The total amount *recorded* for the monsoon period, which is synonymous with the whole year, was 56 lbs. of nitric nitrogen per acre from the 3-foot gauge, and 106·4 lbs. from the 6-foot gauge. These amounts are however below the truth, for drainage was lost in July which it is certain contained a very considerable amount of nitrate, and although any estimate of unrecorded quantities is open to possible criticism, still the amount of nitrate lost I estimate to be 16·4 lbs. of nitrogen from the 6-foot gauge, making a total of 122·8 lbs.; and 18·0 from the 3-foot gauge, bringing its total to 74 lbs. These are greater quantities than those recorded at Rothamsted, the largest there being (so far as I know) 59·62 lbs. per acre in 1880. But no records of the nitrate from the 20" gauge were maintained for seven years after these gauges were constructed, and there is every reason for supposing that the quantity was greater at first than later.

It is of first importance to recollect that these gauges are in each case kept free from vegetation, and that the presence of vegetation on them would probably very materially modify the quantities of water and nitrate passing away. In fact these gauges at present provide conditions of maximum loss. The intention is to keep some of the gauges at Cawnpore and at Pusa under the influence of vegetation, so that on the one hand a record of maximum loss of water and nitrate, and on the other hand the minimum loss may be obtained.

16. **Waters.**—Although a considerable number of well and canal waters have been examined for the several provincial agricultural departments, only two series of such specimens require notice here.

One had reference to the agricultural value of some wells in Gujarat, the water of which is highly prized for tobacco crops. It was readily shown that this value is due to the presence of high proportions of nitrates. Some of these waters contain, indeed, so much nitrate that they cannot be employed without previous dilution with other less salty water. The nitrate is not always the potash salt; indeed in those

samples which contained most, the nitrate was almost exclusively the sodium and lime salt. The details of the work were published as Agricultural Ledger No. 14 of 1895.

Another series of very saline waters from the Muttra District, United Provinces, was examined in 1901. Some of these likewise contained high proportions of nitrate, but the more pronounced characteristic was the presence of large quantities of other salts such as calcium, magnesium and sodium sulphates, and magnesium and sodium chlorides. The investigation was published in Trans. of the Chem. Soc., Volume 81.

17. **Manures.**—A very considerable number of samples of manures of all descriptions has been analysed, and the average composition of the principal kinds is now known. A ledger on this subject was published in 1897 (No. 8), and it will shortly be possible to publish a more complete paper of the same nature.

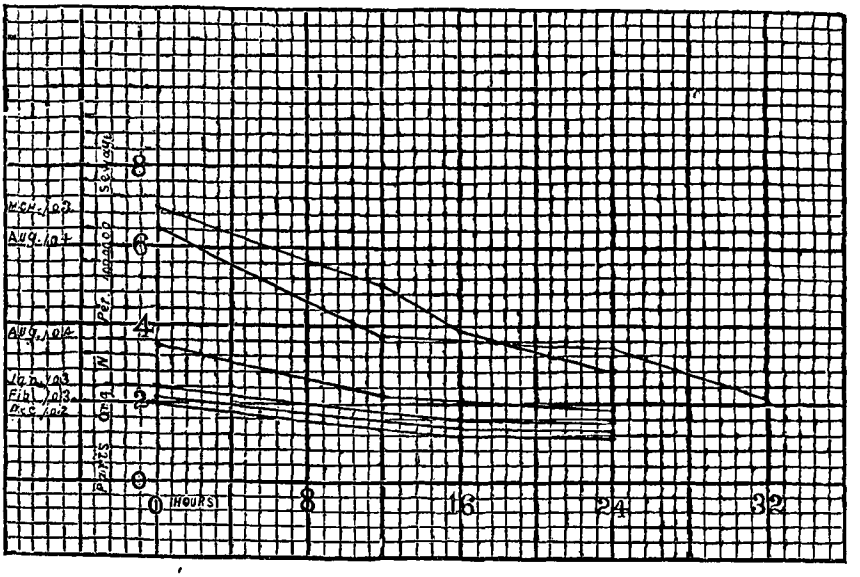
Experiments with manures have not so far been made independently by me; no experimental farm is attached to this office at Dehra Dun, and my province has been restricted to that of adviser at other farms. Sewage has been a subject of special investigation, and is dealt with in the succeeding paragraph.

Among experiments made at the farms, I submitted in 1899 those on the continuous growth of wheat and maize at Cawnpore to a comparison with the similar ones at Rothamsted and Woburn in England (*vide* North-Western Provinces and Oudh Bulletin No. 9 of 1900). A study of the figures is of considerable interest and illustrates well the value of manures, especially nitrogenous manures, in India.

18. **Sewage.**—A series of tests was carried out in 1903 and 1904 at the Manjri sewage farm near Poona in order to determine the rate at which domestic sewage of different strengths becomes purified. The experiments on the use of the septic tank and beds had been in progress for several years at Poona, but excepting for odd analyses made several days after the samples had been taken, little was known of the actual rates of purification. An assistant from this laboratory was, therefore, deputed to the sewage farm, and a series of daily tests of the sewage made during December 1902, January and February 1903, and August 1904. The details of the work of 1902-3 were published in the "Annual Report on the working of the Sewage Farm at Manjri for 1902-3"; those for 1904 have not so far been published.

The principal outcome of the investigation has been to indicate how fast the organic nitrogen becomes hydrolised in the septic tank. This

is best shown by the accompanying chart, from which it is seen that



the rate of change is considerably greater when the concentration of this organic nitrogen is high than when it is low, and that for a strong sewage a relatively smaller tank would be required than for a weak sewage. Secondly, there seems to be a limit to the destruction of this organic matter, which fact is illustrated most perfectly by the curves of the weaker sewage; after the amount of this nitrogen had fallen to about 1 part per 100,000 (hundred thousand), no further diminution occurred, and it is probable that if the tank had been sufficiently large to admit of the strong sewage remaining in it longer, the amount of organic nitrogen would have become practically constant in this case also.

19. The corresponding work on the purification effected in the "Bacteria" or "Contact" beds showed that with septic tank effluent containing about 1 part of organic nitrogen and 1·7 part of ammonia per hundred thousand, three charges could be purified per day; with an effluent containing 2·8 parts of "organic" nitrogen and 4·6 of "ammonia" nitrogen the beds become foul when filled so often.

20. In addition to changes in the character of the compounds in the sewage which take place during bacterial treatment, an actual loss

of nitrogen invariably occurs, and this loss was recorded at Poona. It varies considerably. Out of every 100 parts of nitrogen in the fresh sewage, from 10 to 20 were lost in the septic tank, and a further 10 to 20 were lost in the bacteria bed treatment. The total loss experienced varied from 30 to 40 parts. The magnitude of this loss has not apparently any relation to the strength of the sewage, for it was nearly as great when the weak, as when the strong, sewage was being treated.

21. Since the effect of the bacteria beds is to increase this loss so much, it follows that from the agricultural point of view it would be preferable to run septic tank liquid on to land rather than to submit it to the extra purification. And some of the land at Manjri has been regularly irrigated with septic tank liquid in order to see whether this may be done year after year without harm. The last year's report has not yet been published, but my own opinion, formed after personal inspections of the Manjri land, is that this practice is perfectly feasible, provided of course the quantity of sewage employed be not altogether excessive. On the other hand, it is not good agricultural economy to apply sewage to the smallest area possible; the general aim should be to apply it over the largest area that circumstances will admit.

22. **Canal silt and waters.**—I devoted some little time in 1895 and 1896 to an estimate of the value of the silt which canal water carries with it, and the results were published as Agricultural Ledger No. 5 of 1897..

Samples of canal water were sent by the Executive Engineer from the Upper Eastern Jamna Canal for two years, and the amounts calculated for average quantities of water supplied to wheat, rice and sugarcane. The conclusions arrived at were as follows. (*a*) The silt during the monsoon period supplies considerable amounts of plant food: 32 lbs. of nitrogen and 41·7 lbs. of phosphoric acid per acre were estimated from one set of samples, and 31 and 42 lbs. respectively from another set; quantities which would be of material advantage to a rice crop. (*b*) During the cold weather the corresponding amounts of plant food were only very small; 3·8 lbs. of nitrogen and 5·2 lbs. of phosphoric acid were estimated from one set of samples, and only 5 lbs. and 1·1 lbs. respectively from another. Such quantities would not be of material service to the wheat crop. (*c*) The water supplied to sugarcane over the twelve months was estimated to bring about

8 lbs. of nitrogen, and 10 lbs. of phosphoric acid per acre on to the land, quantities which are quite trivial compared with the requirements of the crop. Naturally the value of silt will vary with the season, and will probably be characteristic of each canal, for it is well known that its nature varies, so far as the eye can tell, from one canal to another. But the investigation was of interest and deserves repetition in other cases.

23. **Saltpetre.**—I have had opportunities during the year to visit saltpetre factories and refineries. The few descriptions of the methods of manufacture, or as it should be styled "extraction," of this salt from earth, speak of the earth being "lixiviated" and "macerated" with water. No more unsuitable terms could be employed, because they imply the use of comparatively large quantities of liquid with the solid, and the inevitable result of this, if applied to Indian saltpetre earth, would be the production of weak liquors. Such indeed is the method employed in Chili when extracting sodium nitrate from the "caliche." But the latter contains very high proportions, such as 30 to 50 per cent. of the salt, whereas Indian saltpetre earth contains but 3 or 4 per cent. As a matter of fact the Indian saltpetre worker employs a process of *percolation* by which a very strong, almost saturated, solution of the salts is obtained at first, and the weaker liquors which follow are simply thrown on the earth and allowed to dry up. By the employment of better percolators more of the concentrated liquor would be obtained, but it is a question whether it would pay to employ capital in this manner. Incidentally also I find that whilst ashes are said to be added to the earth to keep it open and porous, the real advantage lies simply in the fact that these earths generally contain some sodium and calcium nitrate, which are changed by the potash of the ashes to potassium nitrate.

24. Another matter related to this industry that I have had under consideration is the amount of potash salts present in "*sitta*," a product of the refinery process. The process of refining saltpetre is a very simple one. A solution, a "mother liquor" in fact from a previous operation, is taken. This solution at the temperature of the air is saturated with both sodium chloride and potassium nitrate, the two salts which are chiefly involved. On raising its temperature however such a solution would dissolve much more (about eight times as much) potassium nitrate, but practically no more sodium chloride. Hence if crude saltpetre, containing, say, 60 per cent. of potassium nitrate and 30 per cent. sodium chloride, is added to such a liquor at

or near the boiling point, the potassium nitrate will dissolve but the sodium chloride will not. Together with the latter salt any sand and dirt and most of the sulphate of the crude saltpetre will remain. This mixture of salts, etc., is fished out of the pan and drained in baskets. It is called "*sitta*." It is to be observed that the liquid adhering to the *sitta* is a strong solution of saltpetre, and that the *sitta*, unless purified specially, must contain a rather high proportion of this salt. Thus I have found from 2 to 14 per cent. and Mr. Hooper met with even higher proportions. This constituent is far more valuable than either common salt or sodium sulphate. Its market value in the refined state is about R7 or R8 per maund, as against a few annas for the others. Consequently the refiner must regard *sitta* as more valuable on account of its nitrate than in any other sense. In Behar and the United Provinces where I had an opportunity of seeing the processes, *sitta* was simply treated as a source of saltpetre, but in other places I understand that it is used for skin curing and is possibly washed first in this case. Some samples of *sitta* also contain rather high proportions of potassium sulphate and chloride. At one time it seemed to me that this material might be considered as a source of these valuable salts, which indeed could be fairly easily separated on the manufacturing scale, but I am doubtful whether the whole quantity involved is very large, and it is certainly not large in any one place; and secondly, I am not sure whether this potash is not in reality required in the refinery to assist in changing the sodium and calcium nitrates of the nitre earth into the potassium salt.

24. The methods employed in the saltpetre industry, though perhaps less perfect than would be the case in a European factory, are nevertheless far more perfect than published descriptions lead one to suppose. The true value of the refinery earth (not the village nitre earth) is probably not what it is generally supposed. The common view is that it is a source of nitrate and that nitrate grows in it in fact, but this is perhaps doubtful.

25. **Food grains and fodders.**—Information of the chemical composition of Indian food grains and fodders has been gradually collected, and has been published in 1901 and 1903 as Agricultural Ledgers. The latter includes 255 analyses of the grain, straw, etc., of forty different crops.

26. **Oilseeds.**—During the last two years the amount of oil in a considerable number of oil seeds from all Provinces has been determined. The list includes the following :—

		Percentage of oil varied—	
		from	to
52 samples of	Sesamum indicum	45	56
91 „	Brassica (several varieties)	27	49
20 „	Eruca sativa	25	36
31 „	Guizotia abyssynica	36	43
54 „	Linum usitatissium	35	44
30 „	Carthamus tinctorius	22	33
(i) 58 „	Arachis hypogœa	39	50
100 „	Ricinius communis (kernel)	55	71
10 „	Poppy	44	48
(ii) 80 „	Cotton seed	15	21
10 „	Mohwa seed	46	49

In some cases the seed from a certain locality was distinctly superior. Thus samples of sesamum from Kanara contained appreciably more oil than those from most other localities. But considered as a whole, differences in the amount of oil are not readily traceable to locality. As to the relation of variety to percentage of oil, the "Mauritius" earth-nuts from Madras districts contains 45 to 49 per cent. of oil against 40 to 45 in the "local" variety, a well marked difference. But the information supplied was usually quite insufficient to render differentiation on this point possible. Indeed the botanical separation of most crops is not perfect enough at the present time to admit of this. Information regarding the Madras earth-nuts was published in the Madras Agricultural Bulletin No. 41 of 1900. The results of the more recent and major part of this work has been supplied to all Directors of agricultural departments but has not been otherwise published.

27. **Poisonous plants.**—Under this head I referred to several cases of poisonous plants in my last report, all of which contain a cyanogenetic glucoside or glucosides, from which prussic acid is readily produced by the action of a hydrolytic enzyme. The plants specially mentioned were cassava root and jowar (*Andropogon sorghum*). Early in 1904 I examined a series of cassava roots for both free hydrogen cyanide, which has been repeatedly stated to be present, and for a cyanogenetic glucoside. By carrying out the experiments under conditions which would prevent enzymic action on any possible

(i) Done partly in 1900.
(ii) Done partly in 1902.

glucoside, I was able to prove the entire absence of prussic acid in the root. On the other hand, it was as readily ascertained that these roots invariably contain a glucoside, accompanied by an enzyme, and that when the roots are crushed prussic acid is rapidly formed. Tapioca roots from Cawnpore and Assam have also been examined, and none has been found free from this glucoside, though the quantity appears to vary much. The largest amount I have obtained from any roots was 1·25 grain of prussic acid per lb., and the smallest about ·07 grain. The terms "sweet" and "bitter" cassava cannot properly be employed to indicate freedom or otherwise from this ingredient.

The glucoside is apparently situated to a great extent in the pith. Boiling the root destroys the enzyme and prevents the formation of prussic acid afterwards. In an experiment on this point, three roots were boiled for three hours, and two hours later a part of one was crushed with water, and distilled half an hour later. A very faint trace (estimated at ·04 grain per lb.) of prussic acid was obtained. This is not surprising, because during the initial stages of heating it is quite possible for a small part of the glucoside to be acted upon by the enzyme when the cells become fractured and before the temperature has risen sufficiently to inhibit the action, though such opportunity for the action is extremely limited, and it is quite safe to eat the boiled root. On the other hand, I am not satisfied that roasting the sliced root, as is done in the West Indies, is quite safe. In my experiments I found that prussic acid is always found in small quantity by slicing the root, a circumstance to be expected, because the enzyme and glucoside are naturally thus brought in contact, and it does not follow necessarily that roasting would dissipate all the prussic acid formed. A misconception exists in the mind of some writers in newspapers on the subject. Because this acid is a volatile substance, therefore it is assumed that to merely expose the roots to the air is sufficient to provide for its dissipation, but this is a misapprehension, for it requires somewhat protracted distillation to effect this. In the preparation of starch, the prussic acid will naturally be formed, but will be effectively removed from the starch in the wash waters, so that here no danger exists.

28. In May 1904 a case of poisoning occurred among the work bullocks of the Manjri farm. This was readily traced to the glucoside *dhurrin*, which was present in a quite unusual quantity in the fodder. The specimen which reached me produced, when crushed

with water, 1·0 grain of prussic acid per lb. The presence of this glucoside in *Andropogon sorghum* is well known, but usually the quantity is only small.

Some of the seed of the sorghum which had been so fatal to work bullocks at Manjri was obtained and grown at Dehra, but although the glucoside was present in the leaves, the quantity never approached at any period of growth that which had been found in June. It is intended to try again at Pusa to detect under what conditions the glucoside is produced in largest amount.

Other materials which have been examined are Rangoon beans (*Phaseolus lunatus*), Val (*Dolichos lablab*) field peas, gram (*Cicer arietinum*) and Mung (*Phaseolus mungo*). Prussic acid was obtained from all these seeds in quantities varying from ·1 up to 1·1 grain per pound. Soy bean (*Glycine Soya*) was found free from cyanogenetic glucoside.

29. **Sugar.**—The quality of the sugarcane crop in different parts of India is another subject on which much precise information has been ascertained. Commencing with an examination of the cane and *gur* at the Poona, Cawnpore, Dumraon and Burdwan farms, the operations have been gradually extended to other districts. In 1897 the canes in several of the Deccan districts were included, and more recently in 1903-04 and 1904-05 the canes of the Chhindwara, Betul and Balaghat districts of the Central Provinces were the subject of experiment. The result of this extensive work has been to show that the amount of cane sugar in the juice varies from about 10 up to more than 20 per cent. (grammes per 100 c.c.). The latter has been found in some cane of the Balaghat district and at Pusa, and shows what a high standard of cane India possesses, though it is not met with everywhere. Some of the cane at Samalkot is of a similarly high quality. (*Vide* Madras Bulletin No. 51.)

30. The investigations have also shown a considerable variation in the amount of juice expressible by the common iron mill, some canes yielding not more than 60 per cent., whilst from others 70 per cent. may be obtained. Broadly speaking the thick canes yield more juice than thin ones.

31. Again it has been demonstrated that excessive rain and irrigation or manuring tend to produce a juice containing less sucrose and more glucose than it would otherwise do. Whilst the crop is benefited by heavy manuring there is a limit which should not be exceeded. At Poona, manure containing such a large amount as 350 lbs. of

nitrogen per acre may be used economically, but at Cawnpore this quantity was found to be apparently excessive.

32. The quality of the "*gur*" varies very greatly indeed, as the following sufficiently illustrates :—

	Fyzabad *gur*.	Balaghat *gur*.
Sucrose	63·14	85·81
Glucose	9·91	6·49
Ash	3·65	...
Water	8·26	...

These are extreme cases it is true, and the more frequent variation might be stated as: 75 per cent. sucrose plus 10 per cent. glucose in better samples, against 65 per cent. sucrose plus 15 per cent. glucose in poorer samples.

32. A good deal, say, 5 to 15 parts, out of each 100 parts of sucrose in the juice, becomes changed to the non-crystallisable glucose during the boiling process. This change is effected by the acids naturally present in the juice, and attempts have been made, both by me as also by others, to neutralise these acids with lime, and so prevent their inverting action. The result has not been altogether a success. Among a few practically feasible substances which may be employed, lime is one, and at Cawnpore it was used effectively; but great difficulty is experienced in the field (and in the absence of special assistance) in avoiding the use of too much. In the latter case a dark coloured nearly black *gur* is obtained, which has no value in the bazar, although it may be better for the refiner than the usual article.

Greater success has attended the efforts o fSyed Mohammad Hadi, Assistant Director of Agriculture, United Provinces, who has employed sodium bicarbonate. (Details regarding this will be found in the United Provinces Bulletin No. 19 of 1904.)

33. Success in the preparation of a better class of raw sugar is probably more readily attained by preparing the semi-liquid "jaggery" or "rab," and then separating the crystal from the molasses. For this purpose Messrs. Thomson and Mylne introduced a hand centrifugal separator some years ago, and from estimates which I made, more than half of the sugar in juice may be obtained as "brown" sugar containing over 92 per cent. of sucrose and about 2 per cent. of glucose; the molasses, containing the remainder of the sugar, may be then boiled down and produces an inferior *gur* of (say) 65 per cent. sucrose and 14 per cent. glucose. Syed Muhammad Hadi has likewise adopted a hand

centrifugal machine among his improvements, and the product is of even better quality than my Behar samples, and contains upwards of 97 per cent. of sucrose plus only ·5 per cent. of glucose. It is in this direction, as well as in that of good cane and good cultivation, that this industry must be improved. It is true that of two million tons or so of sugar produced in India nearly the whole is consumed as *gur*, and only a small part is refined, still the demand for refined sugar steadily increases; the imports of sugar have risen from about 100,000 or 150,000 to 250,000 tons in the last ten years. Great fluctuations have occurred, but a survey of the statistics seems to leave no room for doubt that the time is rapidly coming when a high proportion of the sugar produced in India will be refined, and the *gur* of today is not well suited to this purpose.

The preparation of brown sugar from *rab* by the cultivator has several advantages over the more general system of sending cane to the refinery. It means that far less has to be expended on transport. The refinery has less molasses to deal with. Also both parties are more independent. If a refinery buys cane, dependence is placed on the cultivator to grow it and supply it within a certain small radius, whilst conversely the cultivator is dependent on the refinery to buy it. If however the cultivator crushes his own cane and prepares "rab" and brown sugar of the quality I met with in Behar, he can sell it in the open market, and at the same time the refiner is not dependent on the cultivator in his immediate vicinity.

34. **Dairy produce—Milk.**—This subject has perhaps received less attention than most others of an agricultural nature in India. Numerous small dairies exist, but the whole subject of dairying has not received a fraction of the attention in India that it does in Europe and America. In these countries the whole of the milk and butter is regularly examined chemically and a very exact knowledge gained of their characteristics. In India this control is conspicuous by its absence. I had one opportunity, when at Poona and Madras in 1899, of examining a series of samples of the milk of individual cows and buffaloes, and this proved of considerable interest. The results were published before the Society of Public Analysts, London, in 1901, and may be very briefly summarised as follows:—(a) Indian cow's milk is not poor, but as rich in butter fat as that of European cows, (b) that of buffaloes is even richer, (c) the general composition of Indian cows' milk is precisely similar to that of European cows, and the relation between the proteids, sugar and mineral matters is the same, (d) that buffaloes' milk contained

rather more proteids than cows' milk, but the proportion of sugar and mineral matters corresponds closely to that of cows.

35. For the *Forest Department* a good many specimens of various kinds, *e.g.* barks, fruits, latex, paper, rosin have been annually examined.

36. **Lectures.**—For some years I delivered courses of lectures; at the College of Science, Poona, from 1898 to 1903; at the Agricultural College, Saidapet, from 1898 to 1903; and at the Imperial Forest School from 1898 to 1904. I have now been relieved of this duty as it was found to interfere seriously with the other work of the department.

37. From December 1904 until June 1905 Babu Har Narain Batham, M.A., of the Agricultural School, Cawnpore, was deputed to go through a special course of training in this laboratory.

38. **Publications.**—A list of publications will be found at the end of this report.

39. **Establishment.**—The establishment of this office has been gradually increased from one up to seven assistants for the chemical laboratory, and one clerk. Only five of the appointments are filled at present, and of these two are probationers. Among the former I have much pleasure in mentioning the following as having done good work: Mr. B. B. Price and Babu Subodh Chandra Kar, assistants in the laboratory, Muhammad Ziauddeen Hyder, the clerk, and Chandi Pershad, a laboratory servant.

40. During the year one of the older assistants died, and one of the probationers has resigned, as he found the work too hard. The new senior appointment has been filled by a probationer of whom I have great hopes; and one of the junior appointments is held by a probationer. There are at present two appointments vacant.

41. There has been and still is great difficulty in finding suitable assistants, and I refer to the matter here in the hope that the publication of the difficulty may aid in removing it. A book knowledge of chemistry is most useful and necessary, but taken by itself it is not sufficient. Young men, the recipients of the highest university honours, and after spending two or three years specially in the chemical laboratory, work with dirty vessels, are generally untidy, and are careless and inaccurate in simple arithmetic. Cleanliness, order and neatness should be a standing rule in any laboratory, and if students who did not comply with it were dismissed from the laboratory, a great advantage would be felt both by employers and employed in after life. Two of the assistants of whom I have had experience this year were both characterised by these grave faults, and they cast great discredit

on their universities. Since these qualifications are essential, it is useless to confirm any appointment until they are obtained.

J. WALTER LEATHER, PH.D., F.I.C.,
Agricultural Chemist to the Govt. of India.

Dated the 22nd July, 1905.

Part IV.

ANNUAL REPORT OF THE CRYPTOGAMIC BOTANIST TO THE GOVERNMENT OF INDIA FOR THE YEAR ENDING THE 30TH JUNE, 1905, WITH A BRIEF ACCOUNT OF THE WORK OF THE OFFICE OF CRYPTOGAMIC BOTANY OF THE DEPARTMENT OF AGRICULTURE SINCE ITS CREATION.

I. PREFATORY.

1. I joined the Department of Agriculture early in April 1902, and have held charge of the office of Cryptogamic Botany of the department since that time. A year previously was spent attached to the Botanical Survey of India in the Royal Botanic Gardens, Calcutta, but as the time was occupied in acquiring some knowledge of the conditions of mycological work in India and was not specially devoted to the agricultural aspect of the science, no reference to it will be contained in the following report.

2. The subject of Cryptogamic Botany includes all the non-seed-bearing plants, that is to say, the *Algæ*, *Fungi*, *Mosses* and *Ferns* and their allies. The chief group of agricultural importance is the fungi and my work has lain mostly with these plants, being such as is usually performed by a Mycologist. In a country of the size of India, with its differences of crops and climates, touring has naturally been of the utmost importance. By this means a knowledge has to be obtained of the principal diseases of crops induced by fungi. The information thus gained has to be worked out in the laboratory, life-histories studied and the general relations between host and parasite examined by laboratory methods. Field experiments under close observation are often required to complete the work and an experimental field of several acres was taken up for this purpose rather over a year ago.

3. The *fungus flora* of India has not been the object of many researches. Collections of fungi made by individuals have been sent to Europe for identification from time to time. The value of this may be gauged by the fact that on several occasions the same fungus sent to two different authorities has been differently determined. Two Mycologists have, however, actually worked in the country, Doctors Cunningham and Barclay, both medical officers in the employment of the

Government of India, and their work has been of the greatest value. Type collections, that is to say, specimens actually named by the authorities by whom they have been examined, are practically non-existent in the country. One of the first essentials is, therefore, to get together a herbarium of fungi collected in India and preserved for reference. Over a thousand specimens have been obtained and in part determined, and these are stored in the herbarium attached to the office. In addition nearly 900 specimens of parasitic fungi have been purchased from abroad for comparison with the indigenous species.

II. ESTABLISHMENT, TOURING AND GENERAL.

4. **Establishment.**—A clerk and two fieldmen were appointed in 1902-03. In 1903-04 two assistants were added and in the present year a third assistant and two more fieldmen. The difficulty of obtaining good men for the scientific posts has been sometimes acutely felt.

5. **Touring.**—I have travelled about 40,000 miles in India in the three years under review, 170 days were spent on tour in 1902-03, 127 in 1903-04 and 151 in 1904-05. The following are the principal tours which have been made and their general objects:—

1902-03.—I visited Coorg in July-August in connection with "spike" disease of sandal trees, Assam in August-September to study some tea diseases, and Bombay (Poona and Surat) in September-October for a preliminary examination of field crop diseases. A short time was spent in October at Nagpur in the investigation of the *tur* (*Cajanus indicus*) wilt disease. In November I visited Behar where a serious outbreak of sugarcane disease had occurred. Several weeks were spent at Cawnpore farm in the spring of 1903 working at cereal rusts, and Hissar in the Punjab was visited for the same purpose in February and April.

6. *1903-04.*—The Bombay government farms at Surat and Poona were visited in August and some experiments in the treatment of ground-nut and *tur* diseases conducted. After seeing the Government sugar station at Samalkot, and spending some days at the Government Botanist's office in Madras working through his collections of crop parasites, I toured in Mysore in September visiting some of the coffee districts and continuing the study of sandal spike disease. Several sugarcane diseases were investigated in Bengal in October and November. In January work was continued at Cawnpore on cereal rusts, and a visit was paid to Pusa in February to examine the sugarcane varieties there for disease at planting.

7. *1904-05.*—A short visit was made to Saharanpur early in August to inspect the fruit trees in the Government gardens in order to decide on the freedom from disease of the grafts and seedlings required for the new fruit garden at Pusa. I spent some days at the Royal Botanic Gardens, Calcutta, in the same month, in the identification of specimens, and have to acknowledge my indebtedness to the staff both on this and on several other occasions for much assistance received. I subsequently investigated a fungus disease of the casuarina plantations at Chatrapur in the Ganjam district of Madras. In September I toured in Mysore in connection with the investigation of spike disease of sandal trees, and in the Coimbatore district of Madras for a preliminary examination of field crop diseases. Pepper vine disease in Malabar and Wynaad and tea and coffee diseases in the Droog range of the Nilgiris occupied most of October, and in the same month I also studied a disease of prickly pear in the Trichinopoli district which the Forest Department hoped might serve as an effective check to the extension of this troublesome plant. Three visits were made to Pusa, in January, February and April, in connection with the Board of Agriculture meeting, sugarcane diseases and the discussion of work connected with the institution with the Inspector General of Agriculture and the other members of the staff; and two to Calcutta, in January and May, in connection with the proposed publications of the department and other departmental matters. A preliminary investigation of some plant diseases in Assam was made in May and June, Shillong, Wajhain and several places in Sylhet having been visited.

8. Munshi Inayat Khan, fieldman, collected specimens in the United Provinces, the Central Provinces and Berars, Central India, Rajputana and the Mussoorie and Simla hills, in the spring of 1904, all primarily in connection with cereal rusts. He also visited Saharanpur in March 1905 in a search for disease-free sugarcane varieties. Mr. Mitra, third assistant, visited Lyallpur, Punjab, in March 1905 to make notes on an outbreak of wheat rust there. Mr. Basu, first assistant, worked in the Government Botanist's office, Madras, in May, 1905, chiefly in carrying out inoculations of pepper-vines with the pepper *Nectria* but was obliged to leave through ill-health before the work was completed.

9. **Provincial work in fungus diseases.**—It is satisfactory to record an increasing interest in the study of fungus diseases of plants in several provinces during the past few years. In Madras, the government farms at Samalkota (sugarcane), South Arcot (groundnut, etc.), and Taliperamba, Malabar (pepper), the last two of which

have been started during the past year, are carrying out investigations in the diseases of these plants under the direction of the Government Botanist. The South Mysore Planters' Association has also determined this year to start an experimental garden, where the study of the behaviour of different varieties of coffee to disease will probably be one of the lines of work. In Bombay some experiments in the direction of finding varieties of *tur* resistant to the wilt disease are in progress at the Kirkee farm, and some work has also been done with the ground-nut disease. At Cawnpore the study of cereal rusts has been taken up by the Deputy Director of Agriculture, United Provinces, and a paper has been prepared in conjunction with myself detailing the results of our work up to 1904, to which has been added a note on the relations of the weather to rust in wheat by Mr. Moreland. The Board of Agriculture has recommended (Proceedings of meeting of January, 1905, paragraph 6) the commencement of work with a view to obtaining varieties of wheat resistant to this disease at a locality in the Punjab and at Hoshangabad in the Central Provinces. The treatment of smut on *juar* and wheat has been found successful at the Nagpur farm and the practice introduced to the cultivators. At Shillong experiments in spraying for potato blight have given a measure of success recorded in the last year's Report of the Department of Agriculture, Assam. A considerable correspondence has arisen in connection with these experiments and as a consequence of frequent enquiries from superintendents of farms, etc., regarding fungus diseases.

10. **Epidemics of fungus diseases.**—Plants are subject in the same measure as animals and man to outbreaks of epidemic disease. Several of these have come to my notice since I arrived in India. Potato blight, for instance, was first noticed in Lower Bengal in 1900 and reached epidemic violence in 1902. It had not previously been known in the plains, though frequently severe in the hills of various parts of India. The mysterious disease of sandal known as "spike" first received detailed mention in a Memorandum by the Deputy Conservator of Forests, Coorg, in 1899. Since then it has rapidly extended, a large part of the Mysore and some of the Madras sandal areas being now infected. The betel palm plague in Sylhet, first reported this year, has only been noticed within the past few years but has destroyed fifteen-sixteenths of the palms in some gardens visited. A mildew on tobacco, recently discovered, threatens an epidemic in Bengal, but has so far been reported from one district only. The

palmyra palm disease in the Godavery delta, apparently of recent origin, appears to have acquired an epidemic frequency this year. The coffee twig disease in the Nilgiris and Neliampatties investigated last year is stated to have appeared about three years ago. It has already done much damage in the infected districts. Of a somewhat different order are the cereal rusts and red-rot of sugarcane which are endemic but have their periods of maximum and minimum intensity. Of the natural laws governing these we have at least some indication. In the case of rusts climatic conditions are apparently all important, while the red-rot of sugarcane probably increases with the increasing number of diseased canes planted, and receives a check when a variety becomes so diseased as to oblige the cultivators to replace it with a less infected kind. The climatic influences in their relation to rust received an illustration last year, when conditions in the earlier part of the season being favourable, rust appeared extremely early. There was every indication of a bad attack resulting, but the disease seemed to receive a check from the great cold experienced this year in Northern India and a general outbreak was averted; though in parts of the United Provinces, in Behar and in Jubbulpore, where the conditions were less unfavourable, severe damage was caused.

11. **Treatment of fungus disease.**—The direct destruction of fungus parasites, in the way that insect pests are dealt with, is often impracticable with the means at present at our disposal. These minute parasitic plants usually occupy the interior of the tissues and cannot be reached by the substances employed without damage to the latter. But their reproductive bodies or spores are ordinarily formed on the surface and set free into the air or soil, and the extension or germination of these may sometimes be prevented. For this purpose spraying with fungicides or removal and burning of diseased parts are employed. But spraying, which is in its infancy even amongst the more highly educated farmers of Europe, is not likely to be adopted generally by the ryots in India for some time to come. And indeed the number of diseases that I have seen in India which are likely to repay spraying is small. Of the ordinary field-crop diseases, potato blight and ground-nut leaf-spot are the chief, and even in these reliable results from experiments in India are not yet available. No special attempts have, therefore, been made to introduce spraying into practice. The other method of preventing spore dissemination, the destruction of diseased parts, is capable of wide application in a number of cases, and this practice has several times been explained and recommended. A group of diseases, chiefly

those known as smuts, is conveyed on the seed. Disinfection here is often comparatively easy and cases of its practical application will be mentioned below. Another group of diseases, chief of which are potato blight and probably sugarcane red-rot, is transmitted by the use of internally affected seed, and the supply of healthy seed is the first requisite in these cases. But for many diseases, for cereal rusts, coffee leaf-disease, *tur* and pepper wilts, etc., the breeding of resistant varieties offers the chief hope of eventual success. I look forward to the time when private seedsmen or Government departments of agriculture will make the supply of resistant varieties and of disease-free seed one of their important lines of work.

III. INVESTIGATIONS OF CROP DISEASES.

12. **Potato diseases.**—An enquiry was made in 1902 into the diseases affecting potatoes, their prevalence and distribution. Potato blight caused by *Phytophthora infestans* was found generally present in the hills, being prevalent in the Himalayas from Bhutan on the east to beyond Simla on the west, in the Khasia hills and in the Nilgiris. In the plains it is less common being obtained from Bengal only. "*Bangdi*" blight, characterised by blackening of the stems and tubers, is a serious disease in Bombay. It is allied to those potato diseases in other countries which have been ascribed to bacterial action. Other diseases of minor importance occur in various localities. An account of the history of these diseases, their causes, and the remedies suggested was published in the Agricultural Ledger series in 1903.

13. **Wheat rusts.**—The study of these, probably the most serious of any crop diseases of India, was commenced in 1903, and has continued each season. The species of rust fungi concerned, their life-history in relation to other plants and the behaviour of different varieties of wheat to their attacks required investigation, practically nothing being known on these points. Much of the work was done in conjunction with Mr. Hayman, Deputy Director of Agriculture, United Provinces, at the Cawnpore farm. A first paper was published in 1903, and a second, in collaboration with Mr. Hayman, has been in the printers' hands for many months, a delay having occurred in printing the plates. Three varieties of rust have been found, the black rust caused by *Puccinia graminis*, the yellow rust caused by *P. glumarum* and the orange rust caused by *P. triticina*. All three are known in Europe. Their distribution has been in part investigated, and search made for other plants on which a

part of the stages in the life-history may be passed. The æcidial stage of black rust, described by Barclay on Simla barberries, has not been found in the hills further east, nor in the Nilgiris. The barberry rusts of these localities are unconnected with wheat rust. This rust, too, was in 1904 the prevalent rust in the central parts of the country, at distances from the habitat of the barberry so great that it is impossible to suppose any connection to have existed. Yellow rust has been found on two grasses, *Phalaris minor* and *Brachypodium sylvaticum*, and Barclay mentions that black rust occurs on a grass, probably *Brachypodium distachyum*, at Simla. But the rusts on the first and third of these do not readily pass to cereals. No other host has been found bearing any of the three rusts, the one remaining likely "intermediate host" *Launea asplenifolia*, the *Æcidium* of which was described by Drs. Cunningham and Prain in 1896, and considered to be possibly connected with orange rust, having been shown experimentally to have no relationship. The conclusion has been arrived at, therefore, that the influence of other plants on the disease need not be taken into consideration. The means by which the disease persists from one wheat season to another are still unknown, the indications being that spore infection from the spores of the previous year's crop will not account for it. The alternative hypothesis put forward by Professor Eriksson of Sweden that disease germs are conveyed in the seed in the form of a protoplasm mingled with that of the wheat plant, has received no experimental support from our work, though it offers a more comprehensible explanation than any other. The experiments are still in progress and consist mainly in growing a few plants of wheat each year in germ-tight cases to determine if any of them will develop rust under conditions which prevent outside infection. The specialisation of the races of the parasite on wheat, barley, etc., *i.e.*, the degree to which the form on each species of host is confined to that host, was investigated. Both the black and yellow rusts of wheat were found capable of passing to barley in some cases. Attempts to produce the yellow rust of wheat from barley failed. Orange rust could not be inoculated on barley, and none of the three on oats. The specialisation of the yellow rust differs to some extent from that observed in Europe. Enquiries made in the Punjab and elsewhere indicate that rust is induced by cloudy moist weather at the season of rust prevalence. This is in harmony with the meteorological observations analysed by Mr. Moreland in their relation to rust in some selected districts of the United Provinces.

14. The chief experiments carried out in 1904-05 were the following. An attempt was made to determine if the first outbreak of rust would be in any way affected by submitting the seed to various degrees of heat before sowing. On Professor Eriksson's theory it was thought possible that a difference of a week or two might be apparent between the first cases in the treated and untreated plots, for it is possible that if any internal germ exist it may be destroyed by heating. In experiments on seed treatment against rust previously carried out in other countries no distinction has been made between the first outbreak, which is usually slight, and the secondary spread caused by spores from the first attacked plants. Yet it is certain that the two sets of cases have a different origin, for the earlier cases can only arise from infection carried over in some way not yet understood from the previous year's crop. Nothing was observed, however, which would lead one to hope that seed treatment by heat will affect even the first cases. An experiment was also made to determine the degree to which the susceptibility of a wheat to yellow rust is dependent on its liability to infection by uredospores produced on the first attacked plants. A tent of cloth sufficient to arrest the passage of air-borne spores was erected over a small plot before rust appeared. On opening, some weeks after the first outbreak, the marginal plants which were exposed to infection carried in by insects at the ground level were found considerably rusted, while those in the centre largely escaped; 160 rusted leaves being obtained from the marginal 78 square feet and only 24 in the internal 112 square feet. Hence in this case susceptibility evidently depended on the liability to secondary uredospore infection. Several determinations of the thermal death-point of the uredospores of yellow rust were made in February and March. Moist heat between 45° and 50° C. for five minutes was found to destroy the power of germination.

15. **Other rusts.**—Over 70 species of *Uredineæ* parasitic on different plants have been identified. Several of these are serious parasites of cultivated crops. Amongst the more important are *juar* rust (*Puccinia purpurea*), *bajra* rust (*P. Penniseti*), linseed rust (*Melampsora Lini*), rusts on indigo, lentil, lucerne, etc. (species of *Uromyces*), several members of the genus *Peridermium* on conifers, teak rust (*Uredo Tectonæ*), castor oil rust (*Melampsorella Ricini*), etc. The *juar* and *bajra* rusts were considered identical by Barclay and described as *Puccinia Penniseti*. They differ however in several important particulars and must be considered two distinct species. Information is

required regarding their life-histories and the extent of the damage caused by them. The linseed rust is very destructive. At Pusa this year it was confined to indigenous varieties and imported flaxes were entirely free. As botanically both plants belong to the same species this affords an indication that the breeding of a rust-resistant linseed is possible.

16. **Sugarcane diseases.**—The most important is red-rot, the disease induced by *Colletotrichum falcatum* which has been so destructive on the East Coast and in Bengal, and which is common elsewhere. Inoculation and field observations both point to the probability of the disease being conveyed chiefly in the canes used for planting and not primarily by spores. The field observations were carried out mainly in Behar where the recent development of sugar manufacture and planting in European hands has directed particular attention to it. In the localities where it was chiefly observed the disease was confined to one variety of cane. The fungus was found in the young plants of this variety and numerous cultures obtained from sets prepared for planting. Spore production was scanty in the fields, and it was found that other varieties could be planted in the diseased land provided that they came from healthy stock. This year inoculations from cultures grown on raw cane, and therefore not likely to have lost their virulence as a result of artificial culture, were tried both on sets at planting and on growing canes. No disease resulted though the canes were grown in boxes to maturity and the fungus preserved its vitality in the short length of cane tissue which it had been able to infect. Further experiments will be required to establish that the disease is seed-borne, and the work is being continued. The outlook is hopeful, for should this view be confirmed, treatment will resolve itself into the selection of unreddened sets for planting, a simple matter. The effects of a rigorous selection of healthy sets for planting on the resulting crop was apparent at Pusa, where 23 varieties from different parts of the country were grown in 1903-04 under somewhat unfavourable conditions. They gave on the whole excellent results, in spite of having had in several cases to undergo a long railway journey. The analyses, which were conducted by an assistant from the Agricultural Chemist's office kindly lent for the purpose, gave as an average of the 23 varieties 18·13 cane sugar and ·498 glucose, while excluding six varieties grown under the shade of trees in unsuitable soil, the remaining varieties gave an average of 19·11 cane sugar and ·380 glucose. As the object in view is to

establish a stand of healthy cane for future experiments at Pusa, an area of over 5 acres has been planted this year with these varieties submitted a second time to careful selection under my supervision.

17. A set-rotting fungus, *Sphæronæma adiposum*, was found in Behar and Dehra Dun in 1903-04. Its life-history, which possesses several points of interest, was followed and the relations of its different spore forms determined. Experiments to test the infection of sets in the field failed through an attack of white ants, but the fungus was found capable of rapidly rotting cut canes in the laboratory. An examination of failed sets obtained in the vicinity of Dehra Dun in 1904, gave this fungus as the apparent cause of the rotting in 61 cases, *Diplodia cacaoicola* in 6, *Schizophyllum commune* (a doubtful parasite) in 5 and white ants or rot from undetermined causes in 89 sets. Inoculations made in 1904 showed that this fungus does not readily attack growing canes.

18. The "pine-apple-disease" producing fungus *Thielaviopsis ethaceticus*, which is very destructive to cut sets in other countries, has not been found indigenous in India, but two occasions have come to my notice of its introduction from Java and Mauritius in both of which I was able to obtain the destruction of the consignment. As the monetary loss in one of these cases was considerable, and as the danger of introducing into India cane diseases from other countries is a very real one, I made the following suggestions for Government action in 1903:—(1) that cane imports for the purposes of field cultivation should be prohibited; (2) that importation for experimental cultivation should be permitted subject to the proviso that full information should be supplied to the department of agriculture and the cane be liable to inspection and to compulsory destruction should it be found diseased; and (3) that the departments of agriculture should be exempted from the action of these checks. Under case (2) the question of the advisability of providing compensation was raised. Government did not however consider that the time had come for such action, and it was decided only to issue through the press a warning against the introduction of diseased canes from Java and Mauritius.

19. Various other diseases of the leaf and stem of sugarcane were investigated in Bengal in 1902 and 1903, and a full illustrated account has been completed since May 1904, but the printing of the plates has delayed its publication.

20. **Fermentation of cane sugar by fungi.**—In June and July 1904, the effect produced by the two fungi *Colletotrichum falcatum* and

Sphæronæma adiposum on solutions of cane sugar was investigated in conjunction with the Agricultural Chemist. The loss of crystallisable sugar caused by the red-rot disease, due to the first of these, is altogether out of proportion to the area of cane infected which is often only one or a few internodes. Proof was obtained that this results from the action of sugar-inverting ferments produced by the fungi, that of *Sphæronæma* being considerably the more active. It appeared probable from the experiments that the ferment is not diffusible but is formed and remains within the cells of the fungi.

21. **Spike disease of sandal.**—The sandal-growing areas in Mysore and Coorg infected with this disease were visited in 1902, 1903 and 1904. No parasitic cause was discovered. The other causes assigned, such as fire, poor soil, want of shade, the presence of the Lantana shrub, which has invaded a considerable portion of the infected area, etc., were found to be insufficient to account for the facts. Observations regarding the infective nature of the disease were made and its extension watched. A large number of inoculations with different parts of the diseased tissues were tried but all have failed to take. As the prosecution of the enquiry would entail prolonged investigation carried out on the spot, the disease being most obscure, and as my time is fully occupied elsewhere, I was obliged to abandon the work until a more favourable opportunity arises. A note was published in the *Indian Forester* in 1903 and a critical examination of the views expressed on the disease by the Conservator of Forests, Mysore State, in the same in 1904.

22. **Tea and coffee diseases.**—A number of these have been seen in Assam, Dehra Dun and South India. Red rust caused by the *Alga, Cephaleuros virescens*, is probably the most serious tea blight. It was found widely distributed on jungle trees and shrubs and can doubtless pass to tea from these. From its absorbent character it was considered probable that spraying with Bordeaux mixture would prove advantageous, and this practice has been recommended by the scientific officer of the Indian Tea Association as a result of his experiments with it on tea estates. Thread-blight which is prevalent on tea in some districts appears to spread mainly by the blowing about of attacked leaves, some experiments in 1902 indicating that it cannot attack the bushes from below as was suggested by the Kew authorities at one time. Stump-rot or root-rot caused by various members of the genus *Resellinia* is common on both tea and coffee estates. These diseases

ordinarily originate in old rotting jungle or shade tree stumps. Hence on cleared jungle land they may become alarmingly frequent. Where, however, the nature of the disease is understood and prompt measures are taken, the damage can often be checked. Certain trees only seem capable of starting the disease as they rot, and the destruction of the roots of these by uprooting or burning out, has in some places been found practicable. As the number of foci of disease is often small and as propagation normally occurs through the upper layers of the soil, surrounding diseased areas by a trench is almost always successful in preventing its extension. Spore-production is not common and probably plays no considerable part in the history of the disease. A short note on stump-rot in tea and coffee was prepared for the South Mysore Planters' Association and printed in their Proceedings in 1903. Another root disease of tea which has appeared in a few localities was investigated in 1902. It was found due to an undescribed fungus of the genus *Diplodia*. Recently a serious coffee disease has appeared in the Nilgiris and Neliampatties. It is characterised by the dying back of the twigs, loss of leaves and rotting of the berries. It is constantly associated in the cases seen with a fungus (*Glœosporium*) to which the cause is assigned. Similar diseases are known to be produced by fungi of this genus and of the allied one *Colletotrichum* on orange and other trees. Experiments on spraying with Bordeaux mixture, the effect of wind belts, etc., are being carried out on an estate in the Nilgiris, but their result has not yet been reported. A number of other diseases was collected and an account of them will be published at a later date.

23. **Tur wilt.**—*Cajanus indicus* (*tur* or *arhar*) suffers commonly from a disease marked by the complete or partial drying up of the plant. It has been found over a large part of Northern India. The cause of the disease, which was first investigated in 1902, is a *Nectria* fungus which laboratory study has shown possesses four distinct spore-forms. Numerous experiments have been made in order to trace its mode of action. It is principally soil borne but also carried by the wind and possibly on the seed. Inoculations, chiefly made in 1904-05, have given very irregular results, the best being 20 per cent. of successes, while several series altogether failed. No explanation is available of this behaviour.

24. **Pepper diseases.**—The pepper vine disease in Malabar which has caused very great losses in the Wynaad and appears to be endemic on the Malabar coast was found constantly associated with a *Nectria*

which on cultivation in the laboratory proved to be indistinguishable from that of the *tur* wilt above-mentioned. As the causal connection has been proved by inoculation in the latter case, and as the two diseases are entirely similar in their pathological aspects, little doubt remains that they are identical. Arrangements were made for inoculation on pepper vines grown for the purpose by the Government Botanist, Madras, but the illness of Mr. Basu, who was deputed to carry them out, obliged their abandonment while still unfinished. Delays and difficulties of this character are inseparable from work attempted at a distance from head-quarters. The treatment of these wilt diseases resolves itself into the attempt to obtain resistant varieties, for they are not amenable to direct treatment. In the case of an annual like *tur* this should not be too difficult and varieties have been got together for the purpose at Kirkee and other farms. In a slow growing plant like pepper it becomes a formidable problem. The newly established pepper station in Malabar will no doubt be able to devote attention to this subject.

25. A second pepper vine disease has been known for a number of years in the Mysore ghat tracts. Instead of mere drying up of the vine without injury to the standard or living tree on which it grows, as in the case of the Wynaad disease, vines and standards are killed out in patches in this other form. The examination of a large number of specimens sent to Dehra showed the disease to be caused by one of the root rotting parasites of the genus *Rosellinia*. The particular species proved to be *R. bunodes* which has not previously been noted as a parasite. Treatment is hopeful in this case as the number of foci of disease is usually small and propagation can probably be checked by trenching as in the case of the similar diseases of tea and coffee.

26. **Other wilt diseases.**—Similar diseases to the pepper and *tur* wilts have been observed in Deccan hemp, soy bean and fennel, but the *Nectria* stage was not found. A gram wilt is also prevalent at Poona but the fungus concerned has not been isolated.

27. **Ground-nut leaf disease.**—A disease known in Bombay as *tikka* disease is a cause of much damage to the ground-nut crop in Bombay and Madras. It is caused by the fungus *Septoglœum Arachidis* first described from Java in 1898, and found also in German East Africa. The leaves are attacked and become covered with dark spots surrounded by a yellow areola, later on falling off. Nuts produced on badly attacked plants are shrivelled and worthless. Spraying with Bordeaux Mixture was tried at the Kirkee farm in 1903, but the results

were not conclusive. An experiment was made in 1904 to test the conveyance of the disease in the seed or in soil. Seed from Poona where the disease is common was sown in Dehra Dun where the crop is unknown and where the danger of air-borne infection might be neglected. Some plots were sown without further treatment while to others was added soil from a field at the Kirkee farm which had borne a diseased crop the previous year. All the plots took the disease indicating a probability that infection can be transmitted by the seed. Seed treatment is being tried this year at Pusa on the seed obtained from this diseased crop. As the amount of damage caused varies with the degree to which the nuts have formed before the attack begins, an attempt has been made this year by sowing a couple of months before the rains to produce an early crop.

28. **Oat smut.**—Treatment of oat seed with formaline and copper sulphate against smut was tested in 1904-05 at Dehra Dun. The plots were about ½ bigha in size. On the untreated plot 172,495 smutted ears to the acre were found. On the formaline plot, treated by soaking the seed for 4 hours in ·1 per cent. formaldehyde, 1,092 smutted ears only appeared, while the two copper sulphate plots, treated respectively with ⅛ per cent. and 1 per cent. by soaking for 24 hours, gave 2,115 and 1,069 smutted ears. The prolonged treatment with copper sulphate injured germination considerably especially with the 1 per cent. solution, while giving no better results than the formaline which was not injurious. The latter is, therefore, considered the more satisfactory. As smut is very bad in Dehra Dun, affecting about 10 per cent. of the ears, an attempt will be made this season to introduce the treatment into practice. It is extremely simple in application.

29. **Other smuts.**—Smuts of wheat (*Ustilago Tritici*), barley (*U. Hordei*), rice (*U. virens*), sawan millet (*U. Panici-frumentacei*), etc., have been frequently obtained and indications for treatment given.

30. **Sorghum diseases.**—*Juar* suffers from a number of fungus diseases. Besides rust, already mentioned, the following have been investigated:—Smut: two varieties are common, caused by different fungi, *Ustilago Sorghi* and *U. Reiliana*. The former can be successfully treated with copper sulphate and experiments are in progress to determine at what stage infection occurs and to compare formaline and copper sulphate treatments. The germination of the spores has also been followed as a preliminary to tracing the complete life history. *Colletotrichum Lineola* is a common cause of a leaf-disease and *Phyllosticta sorghina* has been found causing a somewhat similar

affection. A curious leaf shredding disease has also been observed but the fungus associated with it has not yet been determined.

31. **Green ear disease of the bulrush millet.**—A common condition of the *bajra* millet, in which the whole ear becomes converted into a brush-like head with transformation of the floral leaflets into small distorted foliage leaves and no formation of grain, has been noticed in Bombay, the Punjab and Madras. The cause was determined last year to be an undescribed fungus of the genus *Sclerospora*, other members of which similarly affect various cereals. The life-history of this fungus remains to be worked out, and treatment cannot be suggested until it is known how it originally attacks the plant.

32. **Diseases of trees.**—A large number of diseases of fruit and forest trees have been investigated in the past three years. The deodar forests in Jaunsar are much damaged by the root fungus *Fomes annosus*. Its mode of action was studied and extension found to depend largely on the production of rhizomorphs or organised strands of fungal tissue. Their occurrence in this species was not previously known and influences considerations regarding treatment. The effect of the fungus on deodar wood was also examined. An account was published in the *Indian Forester* in 1903. A second disease caused by the rust *Peridermium Cedri* has recently been obtained on the same tree, and is said to cause much damage to young plants. *Pinus excelsa* is attacked by *Trametes Pini* near Simla, specimens having been received in 1904. It was not previously known to exist in India though a serious pest in German forests. A babul disease has been reported to be destructive in the Berars. Its cause has been ascertained to be *Fomes Pappianus*, a fungus not previously reported as a cause of disease, but found in Abyssinia on acacias. The casuarina plantations on the East Coast are attacked by a disease in some places. The cause was found on examination at Chatrapur in 1904 to be an undescribed fungus of the genus *Trichosporium* which attacks the base of the tree. A description has been drawn up including some suggestions for treatment and communicated to the Madras Government and the Forest officers concerned. It has been incorporated in some notes on Indian forest fungi which have been sent for publication in the *Indian Forester* and will contain a description of a number of forest pests. Peach leaf-curl caused by *Exoascus deformans*, and leaf diseases of mango, loquat and other fruit trees have been obtained from various localities.

33. **Vine diseases.**—Powdery mildew caused by the vine *Oidium*

and *anthracnose* due to *Sphaceloma ampelinum* were seen at Poona, Shillong, and elsewhere and remedial measures carried out.

34. **Betel palm diseases.**—Two serious diseases of this valuable palm have been investigated. In Mysore a disease known as *Koleroga* was seen in 1903, and its probable cause ascertained to be a *Phythophthora*. Further enquiry has not been possible. In Sylhet the disease known as plague is causing great ravages, and was studied locally in May, 1905. It is of recent origin and due to a fungus which attacks the base of the tree. Its treatment is likely to be extremely difficult and a total loss of many of the gardens is to be feared. The nature of the fungus has not yet been ascertained with certainty.

35. In addition to the above a large number of other diseases of cultivated crops has been received for examination or seen on my various tours. Wherever possible recommendations for treatment have been given.

IV. OTHER INVESTIGATIONS.

36. **Kodra poisoning.**—The poisonous properties often possessed by the grain of kodra (*Paspalum scrobiculatum*), a cereal much grown by the poorer classes in various parts of India, have been more than once referred to some abnormal condition produced by a disease of the plant. Several specimens were obtained from Bombay and the presence of a fungus detected in the seed coats and less frequently in the endosperm. A sample of grain which had actually produced poisoning was obtained in Behar in 1903. Grown in Dehra Dun in 1904 the resulting grain was found to produce the peculiar symptoms of vertigo, etc., in man when eaten. Thirty-seven per cent. of the seeds were found to contain the fungus. Experiments were made with rabbits and rats but neither appeared to suffer from eating the poisonous grain. They are being continued, but until a suitable animal is found for experiment the influence of the fungus cannot be determined. An analogous case, that of *Lolium temulentum* which appears to owe its poisonous properties to a fungus inhabiting the seed coats, and which is at present the subject of investigation from this point of view in Europe, gives an indication that we are on the right track.

37. **Mycorhiza.**—It has long been known that a number of plants live in combination with a fungus which inhabits their roots. To the combination the name mycorhiza has been given. In many cases the fungus occupies the interior of the root and a large number of such "endotrophic" mycorhizas has been examined in the past three years.

The case of the nodule bacilli of the *Leguminosæ* and the evident fact that the plant does not suffer from the association suggests that such mycorhizas play a part in plant nutrition. Experiments to investigate this have been in progress for some time. The fungus has been found in all the cases examined (over 50) to be identical. It refuses to grow satisfactorily in artificial cultures and has never been observed to produce spores. Its handling is, therefore, a matter of much difficulty, and the experiments in progress have not yielded results of much value. It has not been possible to attack the problem seriously owing to constant touring, and the work so far has been mostly preliminary.

38. **Nodule bacilli of Leguminosæ.**—Experiments were started in April, 1905, at the instance of the Inspector General of Agriculture, to determine the effect of inoculation of leguminous crops with bacilli in the manner recently recommended by the United States' Department of Agriculture. The principal departure in this method from those already adopted with varying success in other countries consists in growing the bacilli on non-nitrogenous culture media. In a preliminary test three lots of 30 seedlings each of *tur* (*Cajanus indicus*) were grown in sterilised soil. One lot was inoculated with bacilli prepared according to the method advocated by the United States Department, a second with bacilli grown on media containing nitrogen and the third left uninoculated. Examined after five weeks 404 nodules were found on the first lot, 32 on the second and one on the third. No conclusions can be drawn from a single experiment of this nature. Field tests are being carried out both at Dehra Dun and Pusa, and their results should be of considerable interest. In the case of a widely grown crop like *tur* no great advantage can be expected to result from the practice since the bacilli are doubtless present in the soil in which it is habitually grown, unless it should prove to be the case that bacilli starved of nitrogen are more virulent than those normally present in the soil. The further enquiry is in the hands of the Agricultural Bacteriologist.

39. **Miscellaneous.**—A commencement has been made this year in the collection of the edible fungi of India, which are very little known. A collection of mildews, caused by lower forms of the *Eryiphaceæ* whose identification is very difficult, has been recently sent to Mr. E. S. Salmon at Kew who is monographing the group. Several collections of members of the interesting family of the *Gasteromycetes* have been sent for identification to Professor Lloyd of Cincinnati, who proposes to issue a monograph of the Indian forms. Some fungi

probably concerned in the retting of jute were received from the Special Jute Expert to the Bengal Government in 1905 and their identity determined.

40. A list of publications will be found at the end of this report.

E. J. BUTLER, M.B., F.L.S.,
Cryptogamic Botanist to the Government of India.

Dated the 13th July, 1905.

Part V.

REPORT OF THE ENTOMOLOGIST TO THE GOVERNMENT OF INDIA.

1. **Historical.**—The study of Economic Entomology in India may be said to have commenced in 1888, when E. C. Cotes, in charge of the Entomological Section of the Indian Museum, Calcutta, commenced the investigation of economic insects and inaugurated the publication which later on became Indian Museum Notes. Prior to that date there had been a small collection of insects at the Indian Museum under the care of Wood Mason, Neville and De Nicéville successively. The economic work of this section of the Museum was later extended so as to include the identification of such injurious insects as were sent to the Museum by the Directors of Agriculture from all parts of India. The reports which accompanied these insects, as well as the identifications of the insects, were published in Indian Museum Notes at irregular intervals up to 1901. At that date the Indian Museum possessed a large collection of insects partly of economic interest, which were gradually being identified and named by the co-operation of specialists in Europe; four complete volumes of Indian Museum Notes and a part of a fifth had been published, containing a heterogeneous mass of information and identification of numerous common Indian insects. The field study of pests had not been possible, and the published information served no useful practical purpose to the general public. In January, 1901, Mr. De Nicéville was appointed Entomologist to the Government of India, with head-quarters at the Indian Museum, where he was in charge of the entomological section, but with liberty to conduct his inquiries in the field in all parts of India. The work was terminated by his death after less than one year's service; the valuable results of his inquiries were published in the last number of the fifth volume of Indian Museum Notes. In April, 1903, the present writer was appointed Entomologist to the Government of India; the intimate connection with the Indian Museum was severed and the Entomologist placed on the staff of the Imperial Department of Agriculture. The issue of Indian Museum Notes has ceased.

2. The present Entomologist commenced work in India in April, 1903, and this report covers a period slightly exceeding two years.

Having spent six weeks in preliminary work in the Indian Museum, the Entomologist's temporary head-quarters were placed at Surat; they were transferred to Muzafferpur in October, 1904, and to the Agricultural Research Institute, Pusa, in May, 1905. Some time was spent in securing the equipment and necessary staff, and a considerable amount of time was expended in training the latter, there being no qualified assistants available in India at that time. At the present time the staff includes one special assistant undergoing training, two assistants who are capable of doing useful work, one fully trained fieldman capable of doing independent work in the field, three fieldmen undergoing training, and a trained setter. It has been a matter of considerable difficulty to obtain suitable candidates for these posts, the work being of a character wholly new to India.

3. The Directors of Agriculture in the several provinces of India have assisted the Entomologist by sending specimens of insects injurious to crops together with reports; a large number of such insects has been received not for identification alone, but for preservation in the office and also to enable information to be sent of any practical steps possible to check the pest. As a rule it is not possible to advise any action; such specimens are chiefly valuable as an indication of what the crop pests of India are, though the reports that accompany them are naturally of very unequal merit. It has not been found possible for the Entomologist to visit all localities which are reported to be infested with pests, and this form of assistance will only be possible when there are trained assistants stationed throughout India capable of giving practical advice. Many specimens have also been received from planters, from the Superintendents of Botanic Gardens and from others interested in agriculture and horticulture. The replies sent to such inquiries are regarded as an important part of the work of Entomologist, but they naturally entail a large amount of work. They serve the purpose of bringing the Entomologist in touch with the various phases of agricultural activity in India.

4. **Investigation of crop pests.**—As much time as possible is allotted to the investigation in the fields of the insect pests of crops. It is impossible to do more than carry this on in localities representative of large areas, and special attention has been devoted to the pests of the more important crops. The long periods spent in South Gujarat and in Behar have permitted a careful study of pests and conditions in these areas; this has been supplemented by tours and by

investigation on the government farms. Judging from the records of Indian Museum Notes, the principal pests of crops in the plains of India have thus been under observation and new ones have been discovered which had not been reported. Whilst a very small amount of inquiry in the fields is far more valuable than any investigation conducted solely in a museum, this work cannot be said to be progressing adequately. It is impossible for one observer, with a mass of other duties, to study adequately pests in so large a continent as India. A careful study has been made of the insect pests of cotton, and also of the principal pests of rice, sugarcane, maize, jowari and other millets, pigeon pea, tobacco, mustard and rape. Individual pests of almost every other field crop of the plains have been studied and the pests of garden cultivation observed. In view of the many inquiries received, it has been necessary to become familiar with as many of the more general pests as possible, including all recorded in the Indian Museum Notes; the detailed study of these pests must be a matter of years and is carried on as circumstances permit. At present there are in the collections specimens of almost every known injurious crop pest with a more or less complete amount of information regarding the life-history of the insect; its local occurrence and the best methods of checking it will be investigated as opportunities of touring occur or when assistants can be sent to various agricultural tracts. The basis of this work must lie in the classified collection of injurious insects and the work of the past two years has largely consisted in preparing this basis.

5. **Special inquiries.**—The insect pests of the coffee plant have been the subject of special inquiry in Mysore and the Nilgiris. The Entomologist's familiarity with the same pests in the West Indies has simplified this inquiry which has now been concluded.

The outbreak of the Bombay locust in Western India was also the subject of special inquiry, in co-operation with the Directors of Agriculture in Bombay and the Central Provinces. A considerable amount of assistance was given and the inquiry has now been concluded.

6. **Remedies.**—Every opportunity has been taken of testing remedies that are in use in other parts of the world. This investigation is possible only when injurious insects are met with in sufficient number, and cannot be carried on continuously. The conditions under which agriculture is practised in India differ so much from those of countries where these remedies have been discovered that any attempt to introduce European and American methods must be preceded by exhaustive

trial. Whilst this has not been neglected, the elaboration of simpler methods, suitable to the limited resources of the ryot, has occupied more attention. The experience of other countries is almost useless in India ; methods which appeal to highly trained farmers accustomed to machinery and to scientific devices are viewed with suspicion by the agricultural masses of India and are not always within their reach. At the same time, the ryot is shrewd enough to put aside his scruples if he can be shown that any method pays in practice ; it is only necessary to remember that everything must be demonstrated and that the arguments which appeal to a planter, when backed with what he regards as competent knowledge, have no weight with the ryot. The necessity of actually demonstrating every artificial method of checking pests makes progress very slow, and it is doubtful if methods based, for instance, on changes in agricultural practice, will ever appeal to him. The experiments in insecticides have shown that these have as great a value in India as elsewhere ; it is to be hoped that they will be more freely used on experimental farms as a preliminary to their general use by the cultivators. What may be described as mechanical methods have also great value ; the hopper bag used in the operations against the Bombay locust is an instrument capable of extended use, and this simple method, if generally used, would save an enormous loss caused by certain pests in India. Methods based on changes in the present agricultural practice should be tested on experimental farms, but even when successful will be very slowly, if ever, accepted by the agricultural classes at large. Finally, what may be termed common-sense remedies appear to be largely unknown in India, but there seems no reason why they should not be generally adopted after repeated demonstration. The attitude of the ryot to such methods appears to be blank indifference supported by religious prejudice. The market gardener who laboriously collects the caterpillars from his cabbages, and liberates them in a corner of his field, evidently regards the destruction of his pests from a point of view not in sympathy with more wholesale methods of slaughter. So too the ryot who collects the cotton plants which are infested with the stem borer but leaves them in neat heaps throughout his field, with the natural result that the beetles inside presently emerge and work havoc in his field. It will be a laborious matter to demonstrate such matters so clearly that he will be convinced it means money to him. These considerations must be borne in mind in estimating the progress that has been made which is, perhaps, as great as has been possible.

7. **Beneficial insects.**—A phase of modern entomology is the increasing study of beneficial insects and the continued efforts made to utilize them more directly in the destruction of insect pests. Unfortunately the principles which underlie this branch of biology have in most cases been neglected; the plausible hope that one insect could be made to live on another and so keep it in check has appealed especially to the newspapers and the general public, but there is only a limited application to this attractive principle, and in India this application is very small. The study of the parasites of Indian pests has formed part of the work of this period and will be continued. No immediately practical results can be expected from the study of beneficial insects, not solely on account of the inadequate study of these insects but from the nature of the pests of Indian crops and the conditions under which they live. Time has not permitted the investigation of useful insects, such as silk insects, lac insects, bees, etc. These are special inquiries that should be in the hands of a staff with full time to devote to each of them.

8. **Collections.**—In the course of investigation, specimens of all stages of the lives of injurious insects are collected and preserved. This forms the valuable 'Economic Collection' which is constantly growing. There has also been made a 'General Collection' consisting of specimens of all kinds, preserved and properly stored. This collection is now large and is constantly being added to. It is necessary primarily for teaching purposes, but also as an adjunct to the Economic Collection. The general collection will ultimately serve another purpose, that of assisting the identification of economic insects. There is a lamentable lack of interest on the part of naturalists and entomologists in all the insects of the Indian region except butterflies and moths. The result is that while these latter insects have been to a large extent classified and named, it is impossible to identify any other insect. Not only are there no books on the subject, but it is not even possible to induce European Systematists to undertake the examination of Indian insects. This difficulty can be adequately met only by the appointment of entomologists in India for this work; pending this, it is hoped that European Entomologists may be induced to do some portion of it when they can be provided with really large collections of properly preserved insects. General collections are thus made as large as possible in the hope that this will eventually facilitate the identification of economic insects. The difficulty is not an important one except in regard to publications

and has unfortunately been aggravated by the consignment to European specialists of numbers of badly preserved insects from the Indian Museum collections. The formation of the general collection is also carried on as part of the work of the Insect Survey of India originally started by the Indian Museum.

9. **Indian Museum.**—The new relations with the Indian Museum have been settled, and the Entomologist has been able to advise the Superintendent on matters that concern this section, whilst having no direct supervision over the work of the staff. A special assistant has been appointed in the Museum and trained by the Entomologist to work in the Museum under his general guidance. The collections of the Museum are being re-arranged and put in good order. It is unfortunate that these collections are of very slight value in the identification of Indian insects ; the collections are considerable, but ill-arranged and not fully identified. The climate of Calcutta is extremely adverse to the preservation of pinned insect and it is probably only a question of time before these specimens will be ruined and valueless. It has been arranged that duplicates of insects not already in the Museum collections, which are collected in the General Collection, shall be sent to the Museum ; this is necessary so long as the large reference collections are maintained in the Museum, but it would be advisable to transfer these to a locality where there is a prolonged period of dry weather during the year. The inevitable result of the present policy will be an increasingly large and valuable collection in good preservation at Pusa, and collections at Calcutta, now valuable, but from year to year deteriorating owing to the adverse climate. Should there ever be sufficient accommodation at Pusa it would be advisable to transfer the reference collections from the Indian Museum to Pusa, leaving the exhibit collections in the Museum and making arrangements to renew these from Pusa as they deteriorated.

10. **Work at Pusa.**—The Entomologist is now stationed at the Agricultural Research Institute, Pusa, where work was actually commenced in October, 1904. The farm affords an opportunity of testing remedies in the field under the best possible conditions and allows of the field study of insect pests. It is hoped that the work may be extended on better lines as soon as buildings are available at Pusa for laboratories and the like. An important part of the Entomologist's work will consist in preserving the crops grown at Pusa from the attacks of injurious insects which would render useless comparative

experiments of the value of manures and make the trials of varieties increasingly difficult. The work at present carried on at Pusa consists in checking pests on a fairly large scale with the object of ascertaining the actual cost in practice of remedies suggested. The best possible test of remedies is to carry them out on a reasonable scale, ascertaining, when possible, not only the actual cost but also the increased yield assured by the treatment; this is not always possible but the farm at Pusa actually represents an estate on which all that science suggests is carried out and the actual cost and value ascertained.

11. **Field study of insect pests.**—The great need at the present time is the more extended field study of insect pests in all districts of India. This is work requiring principally a knowledge of agriculture and local conditions, some training in entomology and the possession of certain faculties of observation. The first of these will be found only in natives of the different agricultural tracts of India; an attempt has been made to secure men with this knowledge, who have also the faculty of observation and who can be trained in entomology. Three such men have been trained, at the request of the Departments of Agriculture of the Punjab, the Central Provinces and Baroda. They have commenced independent work, as subordinates of these departments, under the general control of the Entomologist. The experiment has been one of great interest and has given excellent results. Further apprentices are undergoing training for work in Bengal and Bombay. The successful issue of this experiment has largely been due to the initiative and keenness of the men selected for training; the actual training cannot be properly attended to by the Entomologist under the present conditions. Undoubtedly, men can be found who are peculiarly adapted to this work. If the results of entomological inquiry are ever to reach the ryot, it will be through the agency of such men, and it may be urged that this feature is the most promising one in the present work. Entomological investigation is a matter of observation and common sense; first rate entomological assistants can be found in India, and, provided they are not selected from too highly educated men, these men can be trained to do excellent work in the field. This applies to entomology far more than to other branches of agricultural inquiry, and I would urge that there should be a very large development in this direction. The large annual losses from preventible pests in India, the excellent work that is done by trained agriculturists, the fact that such men alone can appeal to the ryot and show him that simple

methods of checking pests are within his reach, such considerations justify the statement that, if entomological science is to be properly brought to bear on Indian agriculture, it must be through the medium of such men; the number required is very large and at least five should be trained yearly for each province. At present the organization for training and utilising these men does not exist, but a small amount of supervision is all that is required, and a single European Entomologist in each province can easily give this for a large number of trained men. I would most strongly urge that a far larger number of men should be trained and set to work; the cost of such men will be far more than met if they are able only to check a single pest in one crop. There should be one such man first in every large tract, then in smaller divisions of large tracts. At the present time there is not even one for some large provinces. It is to this form of extension that I look for the practical results that will eventually spring from the scientific study of entomology, and I trust that it may be possible to extend this over the whole of the Indian Empire.

12. **Publications.**—No medium exists at present for the dissemination of useful information; a great deal has been done by the replies sent to inquiries but this is laborious and far less effective than any form of periodical publication. The results of scientific investigation should be published in a form suitable to those who are in need of such information. The results of the inquiry into pests of coffee were published as a Bulletin. A second bulletin was issued on Cotton Pests in Behar. A series of leaflets was commenced dealing with Insecticides, Spraying machines, Common Pests, and kindred matters. These were printed largely with the object of lessening the number of letters that have to be written in answer to inquiry; whenever possible a leaflet is sent instead of a letter. The issue of further leaflets has now ceased as the information to be contained in them is to be embodied in a book. Two bulletins have been printed dealing with technical matters for the use of apprentices and the staff.

13. **Rural education.**—At the desire of the Officiating Inspector General of Agriculture, the lessons on insects in the Primers used in schools were obtained and carefully examined, with a view to improving the nature of the teaching given in schools throughout India. This is an important question, as it reacts on the agricultural classes and any improvement in the teaching may eventually make the ryot more receptive of suggestion as to the destruction of pests. It has been impossible to take up this question adequately, and the preparation of object

lessons on Insect Life will require the very greatest care. An attempt is being made to exhibit specimens of injurious insects on the experiment farms, at the offices of the Directors of Agriculture and in other suitable places. The proposal has been welcomed by the Directors, and every effort is being made to cope with the demand for specimens. Some time must elapse before this can be put on a good basis and the present staff is inadequate for the increased work. A beginning will be made very shortly and, even if progress be slow, the exhibition of specimens with suitable leaflets will probably prove to be a very valuable medium for disseminating useful information.

14. **Future needs.**—The above paragraphs summarise the progress that has been made during the short period under review. The most valuable developments have been the actual field study of pests and the beginning made in the training of suitable native assistants who have an intimate knowledge of the country and of its needs. Good progress will be made so long as these main principles govern the work—the necessity of actual field study, the value of native assistants in influencing the ryot and bringing actual practical results to him. On the other hand, the work has been and is carried on under very great difficulties; the lack of suitable laboratories is a very great handicap that is felt daily and hourly; the constant heart-breaking difficulty of preserving delicate and valuable collections in totally unsuitable buildings and under very adverse conditions is keenly felt. The work has naturally expanded far beyond the adequate control of a single officer with a small staff; the work of the Entomologist includes (1) the routine work of head-quarters, including a large correspondence in answer to inquiries, (2) supervision of the work of the staff and the training of most of them, (3) training of apprentices, (4) the treatment of insect pests at Pusa, (5) tours to the provinces at the request of the provincial departments of agriculture, (6) the care and classification of the economic and general collections at head-quarters, and their transmission to European specialists for identification, (7) the direction of the work of provincial assistants, (8) the investigation into injurious insects. At the present time there is also much work to be done in the organization of the Agricultural Research Institute. Item (8) alone should occupy the whole time of the Entomologist but has to be done as opportunity permits when routine work is over. The routine work is unnecessarily heavy since it is governed by the rules that apply to executive and administrative branches of Government; it is impossible to conduct a scientific section under the same rules as govern

these branches as has now to be done. Freedom to obtain stores from England direct, at any time and without the present excessive delay, would remove one source of difficulty ; the power to carry over unexpended grants from year to year would admit of greater elasticity in the expenditure and of less waste (this is permitted to the Indian Museum); freedom to transfer sums from one head to another would remove one further difficulty since it is impossible to foresee the requirements of each head. At present the work done is limited by the grants allotted, regardless of the fluctuating demands of scientific inquiry which cannot come within the usual control : what is required is greater freedom to adjust the various sums to the necessities of work, while not exceeding the gross sum allotted.

15. The preliminary work has now been completed, the work is progressing smoothly, and the practical results should be extended first to the experimental farms and later to the cultivator. This cannot be hoped for under the present circumstances ; it is impossible for the present staff to supervise experiments on farms all over India nor is it possible to expect provincial departments to make experiments without a full knowledge of their nature and objects. A large increase in the trained native staff of the provincial departments is the first necessity ; a suitable medium for publication is the second ; with these it will be possible to carry out experimental and regular control of insect pests on the farms, and gradually to extend the knowledge of this work to the cultivator, which is the ultimate aim of this section, one that is steadily kept in view and will be gradually attained. In addition it is hoped that the provision of suitable accommodation at Pusa will also enable the work to proceed more smoothly and rapidly, and will permit of the inception of methods of inquiry that are at present impossible. In conclusion I wish to record the excellent work done by the members of the staff who have shared the difficulties under which the work has been carried on and done their utmost to assist me.

H. MAXWELL LEFROY, M.A., F.E.S., F.Z.S.,
Entomologist to the Government of India.

Dated the 7th August, 1905.

APPENDIX A.

An account of the scientific investigations on indigo which have been, and are being, conducted in India.

Scientific work connected with indigo commenced in India in 1898. During 1897 a marked drop in the prices of natural indigo took place owing to the commercial production and competition of synthetic indigo, and a body called the Indigo Defence Association was formed by some of the proprietors of indigo concerns in Behar to protect their interests. This body was subsequently amalgamated with the Behar Indigo Planters' Association. They decided to obtain the best scientific advice possible, and their choice fell upon Mr. Christopher Rawson of Bradford. This gentleman arrived in India in June 1898 and commenced his experimental work in a small laboratory which had been fitted up at the Tirhoot Planters' Club in Muzaffarpur The outcome of the work of that season resulted in an arrangement being entered into with Messrs. Collingridge, and a laboratory and experimental vats were built at their factory Mosheri, and the work was carried on there by Mr. Rawson during the manufacturing seasons of 1899 and 1900.

During these same years (1898—1900) certain Behar planters formed the "Indigo Improvements' Syndicate" whose object was to conduct experiments in the cultivation of indigo and other crops of interest to the indigo planter. An agricultural chemist, Mr. Hancock, was retained, and he worked at Dalsing Serai under the auspices of Mr. Bernard Coventry.

The Government of Bengal first rendered monetary assistance to these enterprises in November 1900 when a grant of £500 per annum for three years was made to the Behar Indigo Planters' Association to provide the services of a bacteriologist. In 1901 both the Behar Indigo Planters' Association and the Indigo Improvements' Syndicate asked Government for aid in their work, and a grant of ₹50,000 per annum for a period of three years was made on the condition that the planters found a sum of ₹75,000 yearly for the same period, and that the work was conducted by the Behar Planters' Association and the Indigo Improvements' Syndicate jointly. These two bodies accordingly amalgamated during 1901, and Mr. Rawson removed to Peeprah, a large factory in the Champaran District, where a new laboratory and an experimental factory had been arranged for him, whilst work was carried on at Dalsing Serai by Mr. Hancock with the assistance of a biologist, Mr. H. M. Leake.

In 1902 the present writer joined Mr. Rawson as bacteriologist at Peeprah, and extensive experiments bearing on indigo manufacture were conducted there; meanwhile Mr. Leake, the biologist, was alone at Dalsing Serai, Mr. Hancock having left India at the end of 1901. In March 1903, Mr. Rawson left India, and the present writer returned to Mosheri, where Mr. Rawson's early experiments had been conducted until March 1904. The laboratory there had, however, been dismantled in the meanwhile, and work had to be conducted in a small godown.

During 1903, the Bengal Government gave their grant of ₹50,000 to Mr. Bernard Coventry to further the work he had been conducting at Dalsing Serai. Professor

Bloxam was engaged and carried on work there together with Mr. Leake until March 1904, when both of these gentlemen left India. In 1904 the grant of ₹50,000 was again made to the Behar Indigo Planters' Association, but unconditionally. An effort was made once again to resume work at Mosheri Factory, but a satisfactory arrangement could not be entered into with the proprietors. A lease was, therefore, taken of a disused and dismantled factory at Sirsiah near Muzaffarpur, and an experimental factory, laboratory, etc., have been under construction there during the past year. All the fittings, apparatus, etc., purchased by the Behar Indigo Planters' Association and the Indigo Improvements' Syndicate, both independently and under grants from Government, have been removed to Sirsiah, and work is at present in progress there.

Much valuable information has been obtained during the seven years these investigations have been in progress, but the work as a whole has naturally suffered from lack of continuity and co-operation on the part of the workers. The object of all the work has of course been to increase the amount of indigo obtainable from a unit area of land, and it has naturally divided itself into two main sections, the first dealing with the purely agricultural aspect of the case, such as the increase of plant obtainable from the unit area of land or the production of a plant richer in potential colouring-matter, and the second with questions involved in the manufacture of the finished product from the plant. During his five years' work Mr. Rawson dealt with both aspects of the case, and the main results of his investigations are summarised in his final report to the Behar Indigo Planters' Association published in 1904. On the agricultural side much useful information was obtained as to the composition of Behar soils and their response to manurial treatment. As a general rule the soils examined were found to be deficient in available phosphoric acid and to respond remuneratively to treatment with superphosphate, bonemeal or other phosphatic manures. Nitrogenous manures were generally found useful when applied in conjunction with phosphates. These same conclusions were arrived at by Mr. Hancock working under Mr. Bernard Coventry at Dalsing Serai in 1901 (*vide* Indigo Report to Indigo Improvements Syndicate by Mr. B. Coventry for season 1901). Mr. Rawson lays stress on the anomalies which occur in the results of the manurial experiments carried out both by himself and by Mr. Hancock (plots taken in the same field giving in several cases entirely different results under one manurial treatment), and expresses the opinion that "much more work is still needed before one can be justified in drawing general conclusions as to the kind and quantity of manures to be applied in order to obtain remunerative returns." The manurial value of the refuse plant or "seet" obtained in the manufacture of indigo was very thoroughly investigated by Mr. Rawson, and the conclusion arrived at was that in many cases it was as valuable as the indigo produced by a factory or even more so, an opinion shared by most planters in Behar to-day. A method was also devised by Mr. Rawson for determining analytically the potential colouring-matter in the plant and several facts of value were established by its use. It was shown that the leaves were the only portion of the plant from which an appreciable amount of dye can be obtained, and the stage of growth of the plant at which the content of the leaves in the dye-yielding principle is at its highest was established. The leaves of several indigo-bearing plants were analysed, and it was conclusively shown that

those of the Java variety of indigo contain more potential colouring-matter than do those of the plant ordinarily cultivated in Behar.

On the manufacturing side Mr. Rawson's experiments were most complete. Every stage of the process was investigated from the purification of the water used in steeping to the drying of the finished indigo. His recommendations are summarised in the report referred to above and details cannot be gone into here. In the writer's opinion, if Mr. Rawson's recommendations are followed, there can be nothing further to be desired in the purification of water, the oxidising process, and the after-treatment of the crude indigo. In the steeping process there may still be scope for improvement, and this will be touched upon later. As a conclusion to his final report, Mr. Rawson remarks as follows:—"Finally, any further aid (from a technical point of view) to improve the position of the indigo industry can only come, in my opinion, from improvement of the plant by natural selection or by the introduction of some other species (such as Natal plant) capable of yielding a greater amount of colouring-matter."

From this last quarter aid has already come. The Java plant, which was first brought prominently to the notice of planters by H. Bailey, who visited Java on behalf of the Indigo Improvements' Syndicate in 1899, has proved itself of the greatest value to the Behar planter, and its cultivation is spreading as rapidly as the seed supply forthcoming will permit. In a very few years this plant will, no doubt, have almost entirely replaced the variety formerly grown in Behar. It was first grown on an extended scale by Mr. Bernard Coventry at Dalsing Serai, and its advantages were apparent immediately certain difficulties in its cultivation had been overcome. The chief of these was the possession of a hard coat by the seed of the plant, which rendered germination very difficult. It was suggested by the writer in 1902 that this difficulty might be overcome by suitably scarifying the seed in a similar manner to that practised on clover and other hard seeds in other countries. The idea was taken up and proved feasible by Mr. H. Leake, the biologist to the Indigo Improvements' Syndicate, and a machine has now been invented and patented by Mr. G. F. Watson of Messrs. Arthur Butler & Co., Muzaffarpur, by which the operation may be performed on a large scale with perfect success.

Mr. Leake's work at Dalsing Serai was mainly devoted to an enquiry into the sources of supply of the indigo seed ordinarily used in Behar. Much valuable information was obtained on this point which should serve as a guide for any future work on the selection of seed and the control of the supply for Behar. Mr. Leake also carried out an investigation on the localization of the indigo-yielding substance in the plant which, though at present mainly of academic interest, may prove of the utmost value in conducting researches into the physiology of indigo-yielding plants, which must be carried out before the full story of the production of indigo can be told.

Finally, in summing up the history of the past researches on indigo mention must be made of the work of Professor Popplewell Bloxam carried out at Dalsing Serai during 1903-04. The period over which Professor Bloxam's work extended was too short to permit of his arriving at any definite results. An account of it as far as he went is, however, given in his report to the Government of Bengal, dated 1905.

In the course of this report several manurial experiments are described, their chief feature being the supply of various carbonaceous materials to indigo soils with the idea of promoting the growth of the nodule bacteria. The value of the methods proposed remains to be seen, but from the facts that the manures were applied at an unsuitable season of the year, and that the results obtained are quite anomalous, no conclusion can be drawn from the experiments described. In the chemical part of the report bearing on indigo manufacture, the methods in vogue of analysing indigo are severely criticised and several statements made which are open to criticism and which further experience would probably have led the writer to modify. Mr. Leake's work on the germination of Java indigo seed and on the seed supply of Behar, referred to above, are also embodied in Professor Bloxam's report, as well as two interesting papers by the same author (Mr. H. M. Leake) on "the soil in its relation to moisture" and "an investigation of soil temperatures."

The present work at Sirsiah can hardly yet be said to have made a beginning. The buildings, etc., have been under construction there since November last, and a crop of indigo has been grown on the lands leased. The laboratories at Dalsing Serai were dismantled in May last, and the removal of their contents to Sirsiah and the re-fitting there has occupied much time. From August 1904 until May of this year, the present writer worked in the laboratory at Dalsing Serai, and the line of investigation which was being followed, as well as the future work to be undertaken, was described in a preliminary report to the Behar Indigo Planters' Association in January last. On the manufacturing side it is pointed out that, contrary to Mr. Rawson's opinion, there may still be scope for improvement since the efficiency of the ordinary process as determined by him was founded on a method of analysis of leaf which has since been proved erroneous. If this is so, the fault must lie in the steeping process, since there is no doubt that, granted the precautions suggested by Mr. Rawson are taken, the oxidising process is as perfect as possible. The writer's researches into the *modus operandi* of the steeping process were begun at Peeprah in 1902 and continued at Mosheri in 1903, and the results of this work were embodied in a paper communicated to the Chemical Society of London in June 1904 (*vide* Journal of the Chemical Society, 1904, volume 85, p. 870). As a result of these researches it was concluded that the only possibility of improvement in the process lay in the direction of employing water at an elevated temperature. This has been frequently tried, and most recently by Mr. Rawson. He came to the conclusion that the hot water system offered "no advantage over the ordinary steeping process when the latter is carried out under the most favourable conditions; but in wet weather the process would repay the cost of steam." Mr. Rawson's experiments were however conducted at one fixed temperature and for one fixed period of steeping. A preliminary series of laboratory experiments has shown that the exact temperature of the water employed and the exact period of steeping have a very profound effect on the result obtained, and it seemed worth while conducting a series of experiments on a manufacturing scale with the object of determining the optimum combination of time of steeping and temperature of water for the steeping process. This will necessitate at least one whole *mahai* being devoted to this end, and it will form the main object of the experiments carried out both at Sirsiah and at Pusa this year. It may prove that no improvement of economic value can be made in this way, but

this can only be determined by manufacturing experiments. An endeavour will also be made at Sirsiah this year to conduct some trials on new modes of drying and packing indigo and perhaps also of refining. There seems scope for improvement in all these directions. Laboratory work will, of course, accompany all these experiments, and certain researches with a more or less direct bearing on indigo problems, both agricultural and manufacturing, will be undertaken. An investigation is at present in progress having for its object a critical examination of all the established methods of indigo analysis. It is hoped that the points raised by Professor Bloxam may be cleared up once and for all thereby.

On the agricultural side little has yet been done at Sirsiah. It is proposed to carry out experiments on the selection and hybridisation of varieties of indigo, but it is doubtful whether much can be done at this until a trained botanist is made a member of the staff. As has been frequently pointed out this is a most important aspect of the work, and perhaps the direction in which the chief hope of permanent assistance to the industry lies. Certain experiments in growing selected seed were started at Sirsiah, but were unfortunately destroyed by caterpillars. It is proposed to sow an area of Java plant in October, and experiments both in methods of cultivating it for manufacture and for seed production will be started. Manurial experiments will also be undertaken on a somewhat new plan with the idea of endeavouring to remove the anomalies in the experiments hitherto conducted and determining definitely if there is any substance that can be profitably employed to increase the production of indigo from a unit area of land. Certain agricultural experiments have also been started and are in progress at Pusa.

Another piece of work of an agricultural nature which is being undertaken at Sirsiah is an endeavour to prepare cultures of the nodule bacteria peculiar to indigo on the lines which have recently been advocated by Dr. Moore of the United States Department of Agriculture, with a view to carrying out inoculation experiments on indigo lands.

Lastly, mention must be made of a seed farm which is being conducted by the Behar Indigo Planters' Association under their grant from Government at Dasna near Delhi. The farm is supervised by Mr. Flavell, the Manager of the Zamindari in which it is situated. The object with which the farm was started was the production of Java seed for use in Behar. It has however proved that no advantage whatever arises from growing the seed in the north-west districts, and in the writer's opinion, the cultivation of seed there should be discontinued, and seed farms started in Behar. The cultivation of a limited amount of the seed of the Summatrana variety might however be conducted in the north-west with advantage, since it will probably be always necessary to grow a certain amount of the plant in Behar and by having their own farm, planters will be able to control the selection of the seed and be insured of a pure supply. The advantage arising out of such a system of seed production has been apparent at Sirsiah this year, where land sown with seed carefully grown and harvested at Dasna has given far better crops than similar land sown with the seed bought in open market. Experiments in methods of cultivation of indigo seed started at Dasna this year were unfortunately rendered useless by becoming overgrown with weeds, delay in the receipt of money from Government having rendered weeding impossible until too late. There will be a good supply of Java seed forthcoming from Dasna this year, however, if all goes well. Some experiments

in seed cultivation are in progress at Pusa, and others will be carried out at Sirsiah this year.

C. BERGTHEIL,

Agricultural Bacteriologist to the Govt. of India.

SIRSIAH ;
Dated the 14th August, 1905.

APPENDIX B.

Jute Experiments in Bengal.

The production of jute in Bengal has, ever since exportation of the fibre commenced in 1828, expanded so rapidly and apparently with so little effort, that until quite recently, little or no serious attention has been paid to its scientific development. During the last few years, however, jute merchants have come to the conclusion that the quality of the fibre which is now produced is deteriorating and in 1901 a request was made to the Bengal agricultural department to make the matter a subject for investigation. This has been done by carrying out agricultural experiments at Burdwan and elsewhere under the guidance of the Inspector General of Agriculture. The objects of these experiments may be summarized as follows :—

(*a*) to compare the respective fibres produced from different varieties of jute, both as regards weight of outturn and quality of fibre ;

(*b*) to determine the stage of growth at which it is best to cut the plant ;

(*c*) improvement of varieties by selection ;

(*d*) manuring experiments;

(*e*) relative merits of thick and thin sowing ;

(*f*) retting.

As yet, no very definite conclusions have been come to as to which variety or varieties are the best, and when this has been established for Burdwan, it will have to be proved to hold equally well for other districts, before distributing the seed indiscriminately.

As regards the stage of growth at which the plant should be cut,—there seems little doubt that if cut when dead ripe, the yield of fibre is rather greater than if cut earlier; but it also seems equally certain that the quality of the fibre from the late cut plant is not so good as that obtained from the plant cut at an earlier stage. These experiments are being continued, and it is hoped that it may be possible in future to supplement the results by subjecting the samples of fibre produced to chemical and other tests in the laboratory.

The manuring experiments tend to show the superiority of cowdung and castor cake over other fertilizers. Cowdung is the best and cheapest manure when it can be obtained, but castor cake and even a mixture of bonemeal and saltpetre appear to justify their application by yielding an increased net profit. These experiments will doubtless be continued, as the results, if borne out by others, are important. There is much land in the jute districts, especially in places which receive no annual deposit of silt, which responds readily to manure, as one can see at a glance by comparing the crops near the homestead with those a little distance away. The advantage is very much with the former, doubtless on account of the extra manure they receive. If this state of things is to be changed, the raiyat will have to be taught to supplement his scanty supply of cowdung with manures like castor and other cakes which often give results out of all proportion to their present cost.

As regards the improvement of varieties by selection, the Bengal agricultural department has this year taken over plots of land in Faridpur, Mymensing and Rangpur, on which typical varieties of jute, local and otherwise, are being cultivated

for seed alone. It is hoped that by encouraging a vigorous growth of the plants, by allowing them plenty of room, and by sacrificing the fibre for the sake of the seed, an improved strain of plant will be the result. If this scheme proves successful on a small scale—the plots are about 20 acres in extent—, it is proposed to start a system of distribution of seed, obtained in this way, on a large scale.

Retting.—Under this heading may be included all the operations which the plant undergoes during the separation of the fibre from the rest of the plant. After the plants have been cut, they are tied up into bundles and immersed in water, where they are allowed to remain until the fibre comes away easily from the woody portion of the stem. This is brought about by a fermentation during which the tissue in which the fibres are imbedded is softened or dissolved. It is apparently the result of the work of a particular bacterial organism, and sterilized stems of jute inoculated with what are believed to be pure cultures of this organism ret rapidly. A most interesting observation has been made, *viz.*, that if small amounts of ammonia salts and salts of phosphoric acid be added to the water in which the retting takes place, the fermentation proceeds far more rapidly than in pure water. This may prove to be of value commercially. There can be little doubt that a prolonged immersion in water weakens the jute fibre. If, therefore, the time of retting could be materially shortened, a superior fibre would presumably be the result. It is impossible, however, to say anything definite until experiments have been conducted on a larger scale than is possible in the laboratory.

In the course of the investigation into the retting of jute, it was discovered that various moulds, when allowed to grow upon the stems kept in a moist condition, have the power of dissolving or softening the tissue in which the fibres are imbedded, in other words of performing the retting process. This is no doubt the rationale of "dew retting" of flax in Europe but with regard to jute it is of scientific rather than economic interest.

It is most essential for the production of fibre of good colour that the retting water should be clean, *i.e.*, free not only from much suspended earth, but free as possible also from traces of iron in solution. If the water is muddy, the fibre loses its lustre and becomes greyish in colour, and experiments have proved that a brown fibre results from retting in water containing iron. Unfortunately the raiyat cannot always choose his water for retting. A good crop of jute when green weighs between 300 and 400 maunds per acre and it would not pay him to cart such a weight far, even if suitable water were available at a distance. It should always be possible, however, to wash the separated fibre in clean water.

Deterioration.—The possible causes of the deterioration which, it is generally admitted, has taken place of late years in the quality of jute fibre may be enumerated thus:—

1. The plants grown for the sake of the fibre have actually degenerated.
2. Lands not suited to the growth of jute have been planted with it, thus producing inferior fibre.
3. Kinds of jute are cultivated which are unsuitable for the particular locality in which they are grown.
4. Lands growing jute are becoming exhausted owing to insufficient manuring and lack of application of the principle of rotation of crops.
5. Retting is not now performed with the same care as formerly.

6. The deterioration is due to the practice of fraudulent watering of the fibre to increase its weight before bringing it into the market.

The sub-committee of the Board of Scientific Advice pronounce unhesitatingly against the idea of degeneration in the jute plants. They say "the best kinds now as then if cultivated liberally yield excellent crops and their fibre if properly extracted is also excellent."

The second, third and fourth causes undoubtedly account for the appearance in the market of fibre of inferior length and fineness. The experiments at Burdwan, Faridpur, Mymensingh and Rungpore mentioned above, deal with these questions and are to be looked to for a remedy.

Carelessness in separating and washing the fibre after retting is complete is the cause of sticky, dirty fibre. In isolated cases, the raiyat having more than he can do properly may not clean his fibre properly; but this is by no means generally the case.

One of the principal causes of the deterioration of jute fibre is undoubtedly the practice of adding water and sometimes sand to the fibre to increase its weight before bringing it into the market. This practice of fraudulent watering only commenced a comparatively short time ago, but it is now almost universal. Accurate estimations have been made of the amount of water in a number of samples of watered jute. The percentages of water calculated on the wet sample, dried at a temperature of 100°C., varied from 21 per cent. to over 55 per cent. On the other hand estimations have been made of the amount of moisture taken up by jute fibre from a saturated atmosphere at about the temperature of the rainy season. The results, which are fairly consistent, place the maximum of hygroscopic moisture below twenty per cent. under the most favourable conditions.

The balers have to dry the wet jute in the sun before baling it, for jute is a fibre which is exceedingly sensitive to the action of water, and if it is baled or even rolled into "drums" in the wet condition, it soon begins to heat after which rotting of the fibre takes place in an astonishingly short time. There is a very strong probability that of recent years a good deal of fibre which has been wetted has been baled for export before being properly dried. There is little doubt that such fibre would be quite rotten and therefore useless from a spinning point of view when it reaches its destination. It is easy to see from this how impressions have got abroad concerning the deterioration of the jute plant, whereas all the deterioration has really taken place after the fibre has left the hands of the cultivators.

Extension of the area under jute cultivation.—According to the annual returns, the area under jute cultivation and the weight of fibre produced are continually expanding. Nevertheless, the demand continues equal to the supply. In view of the fact that more and more persistent efforts are being made to grow jute in other countries, *e.g.*, in Java, French Indo-China, and West Africa (where £3,000 is said to have been spent last year in experiments) it is advisable to consider whether the area of cultivation cannot be extended from Bengal to Madras, Bombay and Burma, in each of which provinces it has been suggested there are tracts suitable for this purpose.

ROBERT S. FINLOW, F.C.S.,

Dated the 11th September, 1905. *Jute Specialist to the Government of Bengal.*

APPENDIX C.

Outline of the history and the work done by the Mysore State Department of Agriculture.

Complying with a request from the United Planters' Association for Southern India, the Mysore Government appointed an Agricultural Chemist (who arrived in January 1899) to investigate agricultural problems in Mysore and to do all in his power to help the agriculturists of the State. The following year a plan to use the building in which the Geological Department had been doing their chemical work, as part of an entirely new Chemical Laboratory for both the Geological and Agricultural Departments, was sanctioned. The Agricultural Chemist undertook to fit up and take charge of the new laboratories, and began chemical work with two Geological assistants in February 1901 in a part of the building. A year and a half later, all the laboratories housed in a building a little over 100 feet square were practically finished and work has been carried on uninterruptedly in them ever since.

For nearly three years a part of the laboratory compound has been used as a small experimental field, and this year an "Experimental Farm" of about 30 acres has been laid out and has been sown with a preliminary test crop to judge of the uniformity of the soil. On this Experimental Farm are nearly 10 acres of wet land under a permanent tank; the remainder is dry land.

A pot-culture house is being built in the laboratory compound.

The first assistant chemist to the Agricultural Department was appointed in January 1902, and out of four further assistants which have been sanctioned two have just been appointed. A Mycologist and Entomologist was recently appointed but was granted 18 months' leave to work in laboratories in America and Europe so as to get a wider experience in laboratory practice before coming out to India.

The work of the Department is to be confined at present to soils and their crops. Sugarcane and its manufacture into jaggery (*Gur*) and raw centrifugalled sugars have received most attention so far. The sugarcane of Mysore is of particularly good quality. One sample analysed contained less than ¼ per cent. glucose and over 21½ per cent. sucrose, and to find a sucrose content of 17, 18 and 19 per cent. is quite common. In fact if it contains appreciably less than 17 per cent. it is probably either not ripe or over ripe. From a refiner's or sugarmaker's standpoint, the extraction and boiling of the sugarcane juice are very defective. The extraction is generally between 50 to 70 per cent. on the weight of the cane, and a large percentage of the sugar in the juice is lost by fermentation after milling and by inversion during boiling, the latter on account of insufficient liming, the former on account of want of cleanliness. In one case over 13 per cent. of the total cane sugar in the juice was inverted and an average of one extensive set of experiments conducted in one of the best sugar boiling districts (Tumkur) indicated that over 7 per cent. of the total sugar extracted from the cane was inverted before or during the boiling of the juice. Taking that one pound of inverted sugar prevents two

pounds of cane sugar from crystallising, this implies that if these jaggeries are refined there is an average loss in the refinable sugar of 21 per cent. and that in the one experiment quoted above there would be a loss of 39 per cent. of the total sugar extracted in the juice. The inversion caused by overheating on account of boiling over a direct fire instead of by steam seems, if judged by the experiments conducted here, not as great as is generally believed, for in many cases where juice was limed to neutrality, absolutely no inversion could be detected though the boiling was done in an open native iron pan over a direct fire.

The analyses of commercial fertilizers largely used by coffee planters, is another line of work which has received considerable attention since the laboratories were opened. This was done to show the great differences which exist in fertilizers bearing the same name and the advisability of buying and selling fertilizers with a guarantee as to their composition. In nearly all the various oil cakes used as fertilizers by the planters of this State, the maximum nitrogen contents were about double that of the minimum and in safflower cake nearly three times as much, the minimum being below 3 per cent. and the maximum above 8 per cent. In dried fish and other manures similar variations exist. Eve n bonemeal was by no means uniform in composition.

Preliminary manurial experiments with ragi and with different depths of cultivation have been made on a small scale, showing that ragi responds well to liberal treatment, when grown on poor soil. Manurial experiments with coffee conducted for four years have so far only shown that the soil on which these experiments were conducted had enough plant food not to require manuring for four years, as none of the fertilizers, though applied liberally, gave any noticeable increase in crop.

A series of experiments with various English grasses and a number of " drought resisting " grasses supplied by the Department of Agriculture at Washington failed completely in this climate in two successive seasons.

A series of analyses has been made of 51 samples of coffee from different parts of the globe with a view of finding out, if possible, a method by which coffee could be judged as to quality in the chemical laboratory. Thus far the specific gravities of the raw coffee beans (of the same variety and from the same district) have been found to agree fairly well with the market price of the samples tested, and at present the specific gravity of the raw beans appears to be the best index for comparing the quality of the crops from different plots of the same experimental fields at our disposal.

The ripe leaves of twelve of the best varieties of trees used as shade for coffee were analysed to judge of the manurial value of the mulch produced by them. These are reported in the third Annual Report and the nitrogen contents of thirty-one so-called famine foods are to be found in the fifth Annual Report.

A. LEHMANN, PH.D.,
Agricultural Chemist to the Mysore State.

Dated the 7th September, 1905.

APPENDIX D.

List of recent Agricultural Publications in India.

Serial No.	Title.	Author.	Where published.
		General Agriculture.	
1	Text Book on Indian Agriculture, 3 volumes.	J. Mollison, M.R.A.C., Inspector General of Agriculture in India.	Government Central Book Depôt, Bombay, 1901. Price R7-8-0.
2	Note on Improvement of Indian Cotton, 1901-02.	Ditto ditto	Office of the Inspector General of Agriculture in India, Nagpur, Central Provinces.
3	Note on Improvement of Indian Cotton, 1902-03.	Ditto ditto	Ditto ditto
4	Note on Cotton in Burma . . .	I. H. Burkill, M.A., Officiating Reporter on Economic Products to the Government of India.	Government Printing Press, Calcutta, 1904.
5	Note on Cotton in Bhainsi, Nizam's Dominions.	Ditto ditto . .	Ditto , 1905.
6	Note on the question of the possibility of extending cotton cultivation in Burma.	J. Mollison, M.R.A.C., Inspector General of Agriculture in India.	Ditto , 1904.
7	Note on Tree Cotton Experiments of Messrs. Shaw, Wallace & Co. of Calcutta.	F. G. Sly, I.C.S., Officiating Inspector General of Agriculture in India.	Government of India, Revenue and Agricultural Department Government Printing, India, Calcutta, 1905.

8	Cultivation of Longer stapled-cottons at the Cawnpur Experiment Station.	P. Subbiah, Principal, Cawnpur Agricultural School.	Bulletin No. 15 of 1901. United Provinces Department of Agriculture. Allahabad Government Press. Price 6 annas.
9	Experimental cultivation of Egyptian cotton at the Nagpur Experimental Farm.	R. S. Joshi, L. Ag., Assistant Director of Agriculture, Central Provinces.	Bulletin No. 3 of 1901. Nagpur Secretariat Press. Price 2 annas.
10	The Cotton seed oil Industry . .	F. G. Sly, I.C.S., Commissioner of Settlements and Agriculture, Central Provinces.	Bulletin No. 9 of 1902. Department of Agriculture, Nagpur Secretariat Press. Price 3 annas.
11	Note on the cotton-seed oil Industry and the Establishment of cotton seed oil Mills in India.	J. Mollison, M.R.A.C., Inspector General of Agriculture in India.	Agricultural Ledger No. 9 of 1903. Government Printing, India, Calcutta. Price 2 annas.
12	Cultivation of sugarcane in the Bombay Presidency.	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India and J. Mollison, Esq., M.R.A.C., Deputy Director of Agriculture, Bombay Presidency.	Agricultural Ledger No. 8 of 1898. Government Printing, India, Calcutta.
14	The Sugar Industry of the United Provinces of Agra and Oudh.	Sayid Muhammed Hadi, M.R.A.C., Assistant Director of Agriculture, United Provinces.	Government Press, Allahabad, 1902. Price R3.
15	Improvement in native methods of sugar manufacture.	S. M. Hadi, M.R.A.C, M.R.A.S., Assistant Director of Land Records and Agriculture, United Provinces.	Bulletin No. 19 of 1905. Allahabad Government Printing Press. Price 2 annas.
16	Sugarcane in the Godavari and Ganjam Districts.	C. A. Barber, M.A., F.L.S., Botanist to the Government of Madras. Dr. J. W. Leather, Ph.D., F.C.S., Agricultural Chemist to the Government of India. C. K. Subba Rao, B.A., Sub-Assistant Director of Agriculture, Madras.	Bulletin No. 43 of 1901. Department of Agriculture, Madras. Price 2 annas.

List of recent Agricultural Publications in India—continued.

Serial No.	Title.	Author.	Where published.
		General Agriculture—continued.	
17	Sugarcanes of Madras	C. Benson, M.R.A.C., Deputy Director of Agriculture, Madras.	Bulletin No. 46 of 1902. Department of Agriculture, Madras. Government Press, Madras. Price 2 annas.
18	Sugarcane cultivation in the Deccan Districts of Madras Presidency.	C. K. Subba Rao, B.A., Sub-Assistant Director of Agriculture, Madras.	Bulletin No. 50 of 1904. Department of Agriculture, Madras. Government Press, Madras. Price 1 anna.
19	Sugar manufacture. The deterioration of cut sugarcane.	J. Weinberg, Officiating Curator, Indian Museum, Industrial Section, Calcutta.	Agricultural Ledger No. 6 of 1903. Government Printing, India, Calcutta. Price 2 annas.
20	*Saccharum officinarum.* (Sugar manufacture.) The Diffusion Process of extracting sugar from sugarcane.	I. H. Burkill, M.A., Officiating Reporter on Economic Products to the Government of India.	Agricultural Ledger No. 8 of 1903. Government Printing, India, Calcutta. Price 3 annas.
21	*Saccharum officinarum.* The Central Factory system with reference especially to countries growing sugarcane.	I. H. Burkill, M.A., Officiating Reporter on Economic Products to the Government of India, and J. Weinberg, Esq., Officiating Curator, Indian Museum, Calcutta, Industrial Section.	Agricultural Ledger No. 12 of 1903. Government Printing, India, Calcutta. Price 2 annas.
22	*Camellia thea* (The Tea plant.) The Principles of Tea Pruning.	Sir George Watt, Kt., M.B., C.M., F.L.S., C.I.E., Reporter on Economic Products to the Government of India, and Harold H. Mann, M.Sc., F.I.C., F.L.S., Scientific Officer to the Indian Tea Association.	Agricultural Ledger No. 1 of 1903. Government Printing, India, Calcutta. Price 3 annas.

23	The Pests and blights of the Tea Plant	Sir George Watt, Kt., M.B., C.M., F.L.S., C.I.E., Reporter on Economic Products to the Government of India and Dr. H. H. Mann, D. Sc., F.I.C., F.L.S., Scientific Officer to the Indian Tea Association.	Government Printing, India, Calcutta, 1903. Price R3.
24	Report on the cultivation and manufacture of Indigo.	Christopher Rawson, F.I.C. . . .	Behar Indigo Planters' Association, Ld., Muzafferpore.
25	An account of the Research work in Indigo carried out at Dalsingserai station.	W. Popplewell Bloxam, B.Sc. (London), F.C.S., F.I.C.	Bengal Secretariat Book Depôt, Calcutta, Price R5.
26	Papers on Jute, 1902-03 . . .	Department of Agriculture, Bengal . .	Bengal Secretariat Press, Calcutta.
27	Selected Papers on enquiry into Deterioration of Jute, 1903-04.	Ditto . .	Ditto
28	Report on Deterioration of Jute . .	Sub Committee B. of Board of Scientific Advice.	Government Printing Press, Calcutta.
29	*Hibiscus cannabinus* (Bimlipatam Jute). Reports upon Bimlipatam Jute.	Professor Wyndham R. Dunstan, F.R.S., Director, Imperial Institute, London.	Agricultural Ledger No. 11 of 1903. Government Printing, India, Calcutta. Price 2 annas.
30	Sisal Hemp culture	Dr. H. H. Mann, M.S.C., F.I.C., F.L.S., Scientific Officer to the Indian Tea Association, Limited, and James Hunter.	Indian Tea Association, Ld., Calcutta, 1904.
31	*Agave.* The Aloe plant and its fibre .	Department of Agriculture, Central Provinces.	Bulletin No. 4 of 1901. Nagpur Secretariat Press. Price 2 annas.
32	*Marsdenia tenacissima.* (Rajmahal Hemp.) Papers relating to fibre of Marsdenia tenacissima.	Professor Wyndham R. Dunstan, F.R.S., Director, Imperial Institute, London. I. H. Burkill, Esq., M.A., Officiating Reporter on Economic Products to the Government of India.	Agricultural Ledger No. 8 of 1904. Government Printing, India, Calcutta. Price 1 anna.

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Serial No.	Title.	Author,	Where published.
		General Agriculture—continued.	
33	Simple machines for extracting plantain fibre.	R. L. Proudlock, Curator, Government Botanic Gardens, the Nilgiris, Madras.	Bulletin No. 47 of 1902. Department of Agriculture, Madras. Government Press, Madras. Price 2 annas.
34	*Triticum vulgare* (Wheat). Australian methods of testing and improving wheat. Their applicability to India with special reference to the prevention of rust.	W. H. Moreland, B.A., LL.B., C.I.E., I.C.S., Director of Land Records and Agriculture, North-Western Provinces and Oudh.	Agricultural Ledger No. 2 of 1901. Government Printing, India, Calcutta. Price 3 annas.
35	*Piper nigram* (Pepper). Cultivation of pepper in the Bombay Presidency. A further account of manures used in spice gardens.	J. Mollison, M.R.A.C., Inspector General of Agriculture in India.	Agricultural Ledger No. 3 of 1901. Government Printing, India, Calcutta. Price 2 annas.
36	*Manihot utilissima* (*Cassava, Tapioca, Manioc.*) The Tapioca Plant: Its history, cultivation, and uses. A review of existing information.	I. H. Burkill, M.A., Officiating Reporter on Economic Products to the Government of India.	Agricultural Ledger No. 10 of 1904. Government Printing, India, Calcutta. Price 3 annas.
37	*Carthamus tinctorius* (Safflower) . .	Reginald Abbey-Yates	Agricultural Ledger No. 11 of 1904. Government Printing, India, Calcutta. Price 3 annas.
38	Maize at the Cawnpur Experiment Station.	P. Subbiah, Principal, Cawnpore Agricultural School.	Bulletin No. 16 of 1901. United Provinces Department of Agriculture. Allahabad Government Press. Price 6 annas.

39	*Paspalum Dilatatum.* A new fodder grass for India.	Reporter on Economic Products to the Government of India.	Agricultural Ledger No. 1 of 1901. Government Printing, India, Calcutta. Price 2 annas.
40	*Paspalum dilatatum.* A new fodder grass for India.	Department of Agriculture, Central Provinces.	Bulletin No. 7 of 1902. Department of Agriculture, Nagpur Secretariat Press. Price 1 anna.
41	Prickly pear and aloe as fodder for cattle during scarcity.	R. R. Mehta, M.R.A.C., Acting Deputy Director of Agriculture, Bombay Presidency.	Bulletin No. 22 of 1904. Department of Agriculture, Bombay. Bombay Government Central Press.
42	India-Rubber. Papers relating to Rubber from *Willughbeia edulis* and *Urceola esculenta* in Burma.	Professor Wyndham R. Dunstan, F.R.S., Director of Imperial Institute, London. S. Carr, Deputy Conservator of Forests, Rangoon Division. Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India.	Agricultural Ledger No. 10 of 1903. Government Printing, India, Calcutta. Price 2 annas.
43	Rhubarb	Department of Land Records and Agriculture, Assam.	Bulletin No. 11 of 1904. Department of Agriculture, Assam. Assam Secretariat Press, Shillong.
44	The Spanish chestnut	Ditto ditto . .	Bulletin No. 12 of 1904. Department of Agriculture, Assam. Assam Secretariat Press, Shillong.
45	Award on the competition for prizes for silos in the Khasi Hills, 1904-05.	Ditto ditto	Bulletin No. 13 of 1904. Department of Agriculture, Assam. Assam Secretariat Press, Shillong.
46	Shillong Government Farm . . .	Ditto ditto . .	Bulletin No. 10 of 1904. Department of Agriculture, Assam. Assam Secretariat Press, Shillong.

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47	Asparagus	B. C. Basu, M.R.A.C., Assistant Director of Agriculture, Assam.	Bulletin No. 14 of 1904. Department of Agriculture, Assam. Assam Secretariat Press, Shillong.
48	The cultivation of pulse crops in the Assam Valley.	B. C. Basu, M.R.A.C., Assistant Director of Agriculture, Assam.	Bulletin No. 9 of 1902. Department of Agriculture, Assam. Assam Secretariat Printing Office, Shillong, Price 2 annas.
49	Pulses of India. (Assam Valley Pulses.) The cultivation of pulse crops in the Assam Valley.	B. C. Basu, M.R.A.C., Assistant to the Director, Department of Agriculture, Assam.	Agricultural Ledger No. 5 of 1903. Government Printing, India, Calcutta. Price 2 annas.
50	Classified list of cultivated crops in the Bombay Presidency.	W. P. Symonds, I.C.S	Bulletin No. 23 of 1904. Department of Agriculture, Bombay. Bombay Government Central Press.
51	Dates of Sowing and Harvesting important crops in the Bombay Presidency.	H. S. Lawrence, I.C.S., Director of Agriculture, Bombay Presidency.	Bulletin No. 24 of 1904. Department of Agriculture, Bombay. Bombay Government Central Press.
52	Water of the soil	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India.	Government Printing Press, Calcutta.
53	A Note on Agricultural Improvements suitable to North-West Provinces and Oudh.	W. H. Moreland, B.A., LL.B., I.C.S., Director of Agriculture, United Provinces.	Bulletin No. 17 of 1901. United Provinces, Department of Agriculture. Allahabad Government Press. Price 2 annas.

54	Different systems of Housing Cattle and conserving manure in the United Provinces.	P. V. Subbiah, Principal, Cawnpur Agricultural School.	Bulletin No. 14 of 1901 of the United Provinces Department of Agriculture. Allahabad Government Press. Price 2 annas.
55	The utilization of night-soil as manure .	R. S. Joshi, L. Ag., Assistant Director of Agriculture, Central Provinces.	Bulletin No. 5 of 1901. Nagpur Secretariat Press. Price 2 annas.
56	Proceedings of the Board of Agriculture	.....	Government Printing Press, Calcutta.
57	Annual Report of the Board of Scientific Advice.	.....	Government Printing Press, Calcutta. Price 6 annas.
58	Report of the Indian Famine Commission of 1901.	.....	Government Printing Press, Calcutta. Price 14 annas.
59	Report of the Indian Irrigation Commission, 1901 to 1903.	.....	Government Printing Press, Calcutta. Price R1-8.
60	Agricultural Statistics of British India, 1902-03. Agricultural Statistics of Native States .	Director-General of Statistics . .	Government Printing Press, Calcutta. Price R3.
61	Area and yield of certain principal crops in India.	Department of Commerce and Industry .	Government Printing Press, Calcutta. Price 5 annas.
62	The Agriculture of the United Provinces	W. H. Moreland, B.A., LL.B., C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces.	Pioneer Press, Allahabad, 1904.
63	Annual Report of the Department of Agriculture, Bengal.	Department of Agriculture . . .	Bengal Secretariat Press, Calcutta. Price 8 annas.
64	Annual Report of the Department of Agriculture, United Provinces.	Ditto . . .	Government Printing Press, Allahabad Price 4 annas.

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Serial No.	Title.	Author.	Where published.
		General Agriculture—continued.	
65	Annual Report of the Department of Agriculture, Punjab.	Department of Agriculture . . .	Civil and Military Press, Lahore. Price 4 annas.
66	Annual Report of the Department of Agriculture, Bombay.	Ditto . . .	Bombay Government Central Press. Price 10 annas.
67	Annual Report of the Department of Agriculture, Central Provinces.	Ditto . . .	Nagpur Secretariat Press. Price 8 annas.
68	Annual Report of the Department of Agriculture, Madras.	Ditto . . .	Government Press, Madras. Price 4 annas.
69	Annual Report of the Department of Agriculture, Assam.	Ditto . . .	Shillong Secretariat Press. Price Re. 1.
70	Annual Report of the Department of Agriculture, Burma.	Ditto . . .	Rangoon Secretariat Press. Price 7 annas.
71	Annual Report of the Experiment Farms in Bengal.	Ditto . . .	Bengal Secretariat Press, Calcutta.
72	Annual Report of the Experiment Farms in the United Provinces.	Ditto . . .	United Provinces Government Press, Allahabad. Price 8 annas.
73	Annual Report of the Lyallpur Farm in the Punjab.	Ditto . . .	The Civil and Military Gazette Press, Lahore. Price 12 annas.

74	Annual Report of the Experiment Farms in Bombay.	Department of Agriculture . . .	Government Central Press, Bombay. Price 12 annas.
75	Annual Report of the Experiment Farms in the Central Provinces.	Ditto . . .	Secretariat Press, Nagpur.
76	Annual Report of the Experiment Farms in Madras.	Ditto . . .	Government Press, Madras.
		Agricultural Chemistry.	
1	The Composition of Indian soils . .	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India.	Agricultural Ledger No. 2 of 1898. Government Printing, India, Calcutta.
2	Reclamation of Reh or Usar land . .	Ditto ditto .	Agricultural Ledger No. 7 of 1897. Government Printing, India, Calcutta.
3	Ditto ditto . .	Ditto ditto .	Agricultural Ledger No. 13 of 1897. Government Printing, India, Calcutta.
4	The sampling of soils. Transactions of the Chemical Society, 1902, Volume 81.	Ditto ditto .	Chemical Society, London.
5	Manure Farm Yard	Ditto ditto .	Agricultural Ledger No. 3 of 1894. Government Printing, India, Calcutta.
6	Indian Manures: Their composition, conservation and application.	Ditto ditto .	Agricultural Ledger No. 8 of 1897. Government Printing, India, Calcutta.
7	The disposal of night-soil . . .	Ditto ditto .	Agricultural Ledger No. 16 of 1895. Government Printing, India, Calcutta.
8	The value of silt as manure , . .	Ditto ditto .	Agricultural Ledger No. 5 of 1897. Government Printing, India, Calcutta.

List of recent Agricultural Publications in India—continued.

Serial No.	Title.	Author.	Where published.
		Agricultural Chemistry—continued.	
9	Experiments on the growth of wheat and maize at the Cawnpore Experimental Farm.	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India.	Bulletin No. 9 of 1900 of North Western Provinces. Allahabad Government Printing Press.
10	Experiments at the Cawnpore Farm on the growth of wheat (*a*) with green manuring, and (*b*) in rotation with leguminous crops.	Ditto ditto	Bulletin No. 10 of 1900. Government Printing Press, Allahabad.
11	Well waters and soils	Ditto ditto	Agricultural Ledger No. 14 of 1895. Government Printing, India, Calcutta.
12	Some excessively saline Indian well waters. Transactions of the Chemical Society, 1902, Volume 81.	Ditto ditto	Chemical Society, London.
13	Indian Food Grains and Fodders. Their Chemical composition.	Ditto ditto	Agricultural Ledger No. 10 of 1901. Government Printing, India, Calcutta. Price 3 annas.
14	Chemical composition of sugar and sugarcane juice or the raw sugar.	Ditto ditto	Agricultural Ledger No. 13 of 1895. Government Printing, India, Calcutta.
15	Chemical composition of sugarcane and raw sugar.	Ditto ditto	Agricultural Ledger No. 3 of 1897. Government Printing, India, Calcutta.
16	Ditto.	Ditto ditto	Agricultural Ledger No. 19 of 1896.

17	The groundnut crop	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India, and C. Benson, M.R.A.C., Deputy Director of Agriculture, Madras.	Madras Department of Agriculture, Bulletin No. 41 of 1900. Madras Government Printing Press. Price 9 pies.
18	The composition of Indian Cows' and Buffaloes' milk.	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India.	The Analyst, 1901.
19	Procedure to be adopted in the systematic examination of varieties of crops.	Ditto ditto	Bulletin No. 8 of 1900.
20	Some recent investigations in the Chemistry of Agriculture.	Ditto ditto	.....
21	Indian Food Grains and Fodders. Their Chemical composition.	Ditto ditto	Agricultural Ledger No. 7 of 1903. Government Printing, India, Calcutta. Price 6 annas.
22	Agricultural value of City sewage in India.	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India, and J. Mollison, Esq., M.R.A.C., Inspector General of Agriculture in India.	Agricultural Ledger No. 2 of 1903. Government Printing, India, Calcutta. Price 2 annas.
23	The determination of small quantities of Iron.	Dr. J. W. Leather, F.I.C., F.C.S., Agricultural Chemist to the Government of India.	Journal, Society Chemistry Industry, XXIV, page 385.
24	The Tea soils of Cachar and Sylhet .	Dr. H. H. Mann, M.Sc., F.I.C., F.L.S., Scientific Officer to the Indian Tea Association, Ld., Calcutta.	Indian Tea Association, Ld., Calcutta.
25	The Tea soils of Assam . . .	Ditto ditto	Ditto ditto
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List of recent Agricultural Publications in India—continued.

Serial No.	Title.	Author.	Where published.
		Agricultural Chemistry—concluded.	
27	Annual Report of the Agricultural Chemist to the Government of Mysore, 1903.	Dr. A. Lehmann, B.S.A., Agricultural Chemist to the Government of Mysore.	Government Central Press, Mysore, Bangalore.
		Botany.	
1	Note on Provisional Classification of Indian wheats cultivated during 1901-03 at the Poona and Manjri Farms, Bombay.	Professor G. A. Gammie, F.L.S., College of Science, Poona.	Office of Inspector General of Agriculture in India, Nagpur, Central Provinces.
2	Note on the Classification of Indian Cottons (tentative) and cross-breeding experiments at the Poona Farm, 1901-03.	Ditto ditto	Ditto ditto
3	The Indian Cottons	Ditto ditto	Ditto ditto
4	Potato Diseases in India . . .	Dr. E. J. Butler, M.B., F.L.S., Cryptogamic Botanist to the Government of India.	Agricultural Ledger No. 4 of 1903. Government Printing, India, Calcutta. Price 4 annas.
5	The Indian Wheat Rust Problem, Part I.	Ditto ditto	Imperial Department of Agriculture, Bulletin No. 1 of 1903. Office of Inspector General of Agriculture in India, Nagpur, Central Provinces.

6	Stump Rot on Tea and Coffee. Proceedings of Annual General Meeting of the South Mysore Planters' Association, March 1903.	Ditto	ditto	South Mysore Planters' Association, March 1903, Bangalore.
7	Report on spike disease among Sandal wood trees.	Ditto	ditto	Indian Forester, Appendix Series, April 1904.
8	A Deodar Disease in Juansar . .	Ditto	ditto	Indian Forester, Appendix Series, November 1903.
9	Pilzkrankheiten in Indien im Jahre 1903	Ditto	ditto	Zeitschrift fur Polanzenkrankheiten. Bd. XV, 1 Heft, 1905.
10	Pepper Vine Disease. Proceedings of Wynaad Planters' Association, October 1904.	Ditto	ditto	Wynaad Planters' Association, Wynaad.
11	Views on Rai Bahadur M. Muthannah's Report on spike disease in Sandal wood.	Ditto	ditto	Indian Forester, Appendix Series, October 1904.
12	Red Rust. A serious blight of the Tea Plant.	Dr. H. H. Mann, D.Sc., F.I.C., F.L.S., Scientific officer to the Indian Tea Association, and C. M. Hutchinson, Assistant Scientific officer to the Indian Tea Association.		Indian Tea Association, Calcutta, 1904.
13	Diseases of *Andropogon sorghum* in the Madras Presidency.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.		Bulletin No. 49 of 1904, Department of Agriculture, Madras. Government Press, Madras.
14	The Localization of the indigo-producing substance in the indigo-yielding plants.	H. M. Leake, M.A., F.L.S., Economic Botanist to the Government of the United Provinces.		Annals of Botany, volume XIX, 1905.

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Serial No.	Title.	Author.	Where published.
		Botany—concluded.	
15	The occurrence of 'Hard Seed' in *Indigofera arrecta Hochst.*	H. M. Leake, M.A., F.L.S., Economic Botanist to the Government of the United Provinces.	Journal, Royal Horticultural Society, volume XXIX, 1905.
16	Variation in *Indigofera sumatrana Gaert*, as induced by climatic conditions.	Ditto ditto	Ditto ditto
17	A Note on Plants used for food during famines and periods of scarcity.	Professor G. A. Gammie, F.L.S., College of Science, Poona.	Records of the Botanical Survey of India, volume II, No. 2, 1902.
		Entomology.	
1	Note on the Danger of introducing insect pests.	H. M. Lefroy, M.A., F.E.S., F.Z.S., Entomologist to the Government of India.	Leaflet. Office of Inspector General of Agriculture in India.
2	Instructions for destroying Hoppers	Ditto ditto	Ditto ditto
3	The six spotted Lady Bird Beetle	Ditto ditto	Leaflet. Office of Inspector General of Agriculture in India.
4	The Red Cotton Bug	Ditto ditto	Ditto ditto
5	The Cotton Leaf Hopper	Ditto ditto	Ditto ditto
6	The Dusky Cotton Bug	Ditto ditto	Ditto ditto

7	The Success Knapsack Sprayer . .	Ditto	ditto . .	Ditto ditto
8	Insects attacking Cotton . . .	Ditto	ditto . .	Ditto ditto
9	Kerosine Emulsion	Ditto	ditto . .	Ditto ditto
10	Rosin washes as Insecticides . . .	Ditto	ditto . .	Ditto ditto
11	Lead Arseniate	Ditto	ditto . .	Ditto ditto
12	Crude Oil Emulsion	Ditto	ditto . .	Ditto ditto
13	How to rear caterpillars that attack crops	Ditto	ditto . .	Ditto ditto
14	Note on Cotton in Behar . . .	Ditto	ditto . .	Occasional Bulletin, No. 1, Pusa.
15	Insect Pests of Coffee	Ditto	ditto . .	Imperial Department of Agriculture Bulletin No. 2 of 1903. Office of Inspector General of Agriculture in India, Nagpur, Central Provinces.
16	Classification of Insects	Ditto	ditto	Leaflet. Office of Inspector General of Agriculture in India, Nagpur, Central Provinces.
17	Simple spraying apparatus . . .	Ditto	ditto . .	Ditto ditto
18	Fumigation of seeds	Ditto	ditto . .	Ditto ditto
19	Insects injuring sugarcane . . .	Ditto	ditto	Ditto ditto
20	Notes on the work of Assistants . .	Ditto	ditto	Ditto ditto
21	Report on an enquiry into the state of Tasar Silk Industry in Bengal and the Central Provinces.	N. G. Mukerjea, M.A., M.R.A.C., & P.H.A.S., Assistant Director of Agriculture, Bengal.		The Bengal Secretariat Book Depôt. Price R2.

List of recent Agricultural Publications in India—concluded.

Serial No.	Title.	Author.	Where published.
		Entomology—concluded.	
22	The Mosquito Blight of Tea . .	Dr. H. H. Mann, D.Sc., F.I.C., F.L.S., Scientific Officer, Indian Tea Association.	Indian Tea Association, Calcutta.
23	*Acrididiæ.* A plague of Grasshoppers in the Central Provinces.	Stewart Stockman, M.R.C.V.S., Assistant Bacteriologist, Civil Veterinary Department.	Agricultural Ledger No. 3 of 1903. Government Printing, India, Calcutta. Price 3 annas.
33	*Termes taprobanes.* White ants as a pest of trees.	Department of Agriculture, Central Provinces.	Bulletin No. 6 of 1902. Department of Agriculture, Central Provinces, Nagpur, Secretariat Press, Nagpur. Price 2 annas.

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FOR THE YEARS

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TABLE OF CONTENTS.

PART I.—*Report of the Inspector-General of Agriculture in India,* by J. Mollison, M.R.A.C.

Paragraph.		Page.
1.	General duties	1
2.	Staff and means for agricultural improvement in India	1
3.	Rules for appointment in the Indian agricultural service	4
4.	Tours	4
5.	Board of Agriculture	5
6.	The Agricultural Research Institute, Pusa	6
7.	Agriculture	7
8.	„ cotton	8
9.	„ sugarcane	8
10.	Agricultural Chemistry	9
11.	Mycology	9
12.	Entomology	10
13.	Botany	11
14.	Cotton :—Survey of indigenous varieties	12
15.	„ Selection of cotton seed	12
16.	„ Cotton hybridization	13
17.	„ Trial of exotics	14
18.	„ Tree cottons	14
19.	„ Extension of cotton cultivation	15
20.	Tea	16
21.	Indigo	16
22.	Jute	17
23.	Flax	18
24.	Other fibres	19
25.	Tobacco	19
26.	Wheat	19
27.	Groundnut	20
28.	Artificial fertilizers	20
29.	Irrigation	21
30.	Sericulture	23
31.	Agricultural education	24
32.	Distribution of seeds and implements	25
33.	Publications	25
34.	Expenditure	26
35.	Provincial Departments of Agriculture	27
36.	„ „ Bombay	27
37.	„ „ Madras	28
38.	„ „ United Provinces	28
39.	„ „ Bengal	28

PART I.—*Report of the Inspector-General of Agriculture in India*, by J. Mollison, M.R.A.C.—*contd.*

Paragraph.		Page.
40.	Provincial Departments of Punjab	29
41.	„ „ Central Provinces	30
42.	„ „ Eastern Bengal and Assam	30
43.	„ „ Burma	30
44.	Expansion of the Department	30

PART II.—*Report of the Officiating Director, Agricultural Research Institute, Pusa*, by J. Walter Leather, Ph.D., F.I.C., F.C.S.

1.	Charge of Office	33
2.	General work of the Institute	33
3.	Buildings	33
4.	Roads, etc.	33
5.	Medical	33
6.	Training	34
7.	Library	34
8.	Publications	34
9.	Accounts	34

PART III.—*Report of the Imperial Agricultural Chemist*, by J. Walter Leather, Ph.D., F.I.C., F.C.S.

1.	Charge of Office	34
2.	Laboratory	35
3.	General Analytical work	35
4.	Potculture house	35
5.	Available plant food in soils	35
6.	Pusa soils	36
7.	Meteorology	36
8.	Rain and Dew	36
9.	Drain gauges	36
10.	Loss of water from soil	36
11.	Saltpetre	37
12.	Sugarcane	37
13.	Cyanogenetic glucosides	37
14.	Establishment	37

PART IV.—*Report of the Imperial Mycologist*, by Dr. E. J. Butler, M.B., F.L.S.

1.	Prefatory	39
2.	Investigations of plant diseases	40
3.	Sugarcane diseases	41
4.	Cereal rusts	41
5.	Groundnut leaf diseases	42
6.	Wilt diseases	42

PART IV.—*Report of the Imperial Mycologist*, by Dr. E. J. Butler, M.B., F.L.S.—*contd.*

Paragraph.		Page.
7.	Green-ear disease of cereals	42
8.	Mango diseases	42
9.	Other diseases	43
10.	Soil inoculation for legumes	43
11.	Fungus diseases of injurious insects	43
12.	Soil fungi	44
13.	Systematic Mycology	44
14.	Text-book	44
15.	Training	44
16.	Establishment	45

PART V.—*Report of the Imperial Entomologist*, by Mr. H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.

1.	Training	47
2.	Establishment	47
3.	Buildings	47
4.	Provincial work	47
5.	Correspondence	48
6.	Research	48
7.	Insect survey	49
8.	Summary	49
9.	Publications	49

PART VI.—*Summary of the Report of the Imperial Agriculturist.*

1.	Staff	51
2.	Historical	51
3.	Training	51
4.	Cropping	51
5.	Cotton	51
6.	Sugarcane	52
7.	Jute	52
8.	Flax	52
9.	Mangel wurzels	52
10.	Green manuring	52
11.	Trial of new pasture grasses	52
12.	Breeding herds	52
13.	Establishment	52

PART VII.—*Summary of the Report of the Imperial Economic Botanist.*

1.	Prefatory	53
2.	Wheat investigation	53
3.	Tobacco	54
4.	Barleys	54
5.	Ganja	54

PART VII.—*Summary of the Report of the Imperial Economic Botanist*—contd.

Paragraph. Page.

6. Library Catalogue 54
7. Tours 54
8. Staff 54

APPENDIX A.—A short account of recent work in Behar in Indigo Research 55

APPENDIX B.—A short account of experiments with Jute and other Fibres 56

APPENDIX C.—List of recent agricultural publications in India . . 59

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REPORT

OF THE

IMPERIAL DEPARTMENT OF AGRICULTURE

FOR THE YEARS

1905-06 and 1906-07.

PART I.

REPORT OF THE INSPECTOR-GENERAL OF AGRICULTURE.

1. *General duties.*—The duties of the Inspector-General are advisory as regards agricultural investigations which are being carried out in each Province, but they are direct as regards the work carried on at the Government of India Research Institute at Pusa. The Provincial Directors have consulted him freely, and have also readily accepted advice. They have co-operated very freely with each other. Good arrangements have been made for continuity of work in each Province and there is no special overlapping of work. Mr. F. G. Sly, I.C.S., held charge of the office of the Inspector-General of Agriculture in India until 26th February 1907, when after over two years' leave, Mr. J. Mollison, M.R.A.C., permanent incumbent of the post, again took over charge. As the work of the Imperial Department of Agriculture developed it was considered necessary to appoint an assistant to the Inspector-General. Mr. T. F. Main, B.Sc., was appointed in August 1905. His chief work has been to collect information regarding ordinary field and garden crops, agricultural implements, agricultural practices and the like. He was recently specially employed to make full enquiries regarding Coffee and Pepper cultivation in Southern India, to study the methods of keeping Farm accounts in all Provinces in order to offer suggestions to improve them and on an enquiry regarding the natural grasses and pasture plants of India. General work of this kind will be continued. One or two enquiries at a time will be taken up and fully dealt with.

2. *The staff and means for agricultural improvement in India.*—The proposals made to the Secretary of State for India for the expansion of the Agricultural Department have been generally sanctioned excepting those which refer to a third Entomologist and Crop Specialists for Tobacco, Sugarcane, Wheat, Rice and Fruit and Mycological and Entomological Experts in each Province. The appointment of a Cotton Expert has been sanctioned and is likely to be filled soon by a very experienced officer. A fibre expert has been appointed and now works under the Government of Eastern Bengal and Assam. His head-quarters and laboratories and experimental plots are at Pusa. His work in regard to the extension of jute cultivation and other fibres extends all over India, but his chief field experiments are at present arranged for at Pusa.

There are now eighteen appointments in the Imperial Department of Agriculture, *viz.*:—

1. Inspector-General of Agriculture.—J. Mollison, M.R.A.C.
2. Assistant Inspector-General of Agriculture.—T. F. Main, B.Sc.
3. Director of the Agricultural Research Institute and Principal of the Agricultural College, Pusa.—Bernard Coventry.
4. Imperial Agricultural Chemist.—J. W. Leather, Ph.D., F.I.C., F.C.S.
5. Imperial Mycologist.—E. J. Butler, M.B., F.L.S.
6. Imperial Entomologist.—H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.
7. Second Entomologist.—F. M. Howlett, B.A.
8. Imperial Bacteriologist.—C. J. Bergtheil.
9. Imperial Agriculturist.—E. Shearer, M.A., B.Sc.
10. Imperial Economic Botanist.—A. Howard, M.A., A.R.C.S.
11. Imperial Cotton Specialist.—Vacant.
12. Supernumerary Agriculturist.—A. G. Birt, B.Sc.
13. Supernumerary Agriculturist.—W. Roberts, B.Sc.
14. Supernumerary Agriculturist.—G. H. Garrad, N.D.A.
15. Supernumerary Specialist.—C. W. Mason (Entomologist).
16. Supernumerary Specialist.—H. E. Annett, B.Sc. (Chemist).
17. Supernumerary Specialist, R. J. D. Graham, M.A., B.Sc. (Botanist).
18. Supernumerary Specialist.—W. MacRae, M.A., B.Sc. (Mycologist).

The Imperial Bacteriologist has been employed by the Bengal Government in Indigo Research work. He will be able to continue this work when he takes up his permanent appointment at Pusa in April next, but there is much other work which requires his special attention at Pusa. We have found considerable difficulty in getting experienced

Agricultural Experts for particular sections. Therefore, young supernumerary officers have been appointed who are being trained at Pusa and by deputation to various Provinces. The second Entomologist and the supernumerary Mycologist have been selected, but have not yet arrived in India. The former is specializing in work which will be of value to India. The latter has gone to Germany for special studies. In each Province a great advance has been made in the organisation of its Agricultural Department. Each has a nucleus staff consisting in most cases of the Principal of the Agricultural College, a Chemist, a Botanist and one or more all-round practical Agriculturists. There are in all 38 sanctioned appointments for the Provinces as shown in the following table :—

Province.	Deputy Director of Agriculture.	Second Deputy Director of Agriculture.	Principal, Provincial College.	Botanist.	Chemist.
Madras . . .	R. W. B. C. Wood, B.A.	C. Sampson, B.Sc.	C. J. W. Shepperson, B.Sc.	C. A. Barber, M.A.	W. H. Harrion, M Sc.
Bombay . . .	F. Fletcher, M.A., B.Sc.	G. H. Henderson, N.D.A., N.D.D.	H. H. Mann, D.Sc., Principal, J. B. Knight, M.Sc., Professor of Agriculture.	G. A. Gammie, F.L.S.	H. H. Mann, D.Sc. (Chemist and Principal of College).
Bengal . . .	F. Smith, B.Sc.	(not provided)	H. H. Corbin, B.Sc.	W. R. Buttenshaw, M.A., B.Sc.	Vacant.
Eastern Bengal and Assam	Rai Bahadur B. C. Basu, M.R.A.C.	(to be filled locally in October)	(not provided)	(required in October 1907)	(1) A. A. Meggitt, B.Sc. (Agricultural Chemist). (2) R. S. Finlow, B.Sc. (Fibre Expert).
Burma . . .	A. MacKerral M.A., B.Sc.	(not provided)	M. E. Thompstone, B.Sc.	(vacant)	F. J. M. Sc.
United Provinces .	J. M. Hayman, D.V.S.	(vacant)	A. W. Fremantle, B.Sc.	H. M. Leake, M.A., F.L.S.	G. Clarke, F.I.C.
Punjab . . .	S. Milligan, M.A. B.Sc.	(not provided)	A. C. Dobbs, B.A.	(vacant)	J. H. Barnes, B.Sc., A.I.C., F.C.S.
Central Provinces .	D. Clouston, M.A., B.Sc.	(vacant)	G. Evans, B.A., B.Sc.	(vacant)	F. J. Plymen, A.C.G.I.
North-West Frontier Province.	(vacant)	(not provided)			

Note.—Postings made subsequent to June 1907 have not been included in this statement.

Eight of these officers have not yet arrived in India. The sanctioned posts will probably all be filled before the end of the financial year. The Mysore, Baroda and Kashmir States are developing their Agricultural Departments and have each done a great deal to improve Horticulture. The larger public gardens in India are doing much to improve our fruit orchards and are making other improvements. The Planters' Associations in Behar and Southern India have been active in advancing their industries. The Indian Tea Association and Indigo Planters' Association have each a staff of Agricultural Experts.

3. *Rules of Service.*—Uniform rules have been laid down for the appointment in the agricultural service. Local allowances for certain officers of the Imperial Department of Agriculture and Principals of Provincial Colleges have been sanctioned. Separate Departments of Agriculture, distinct from the Land Records Departments, have been formed in nearly all Provinces and are placed in charge of officers of the Indian Civil Service as Directors of Agriculture. The restriction limiting the total emoluments of the Directors of Agriculture to the pay of the Collectors of the highest grade as a maximum has been withdrawn. Definite orders have been issued by the Government of India regarding the authority which can be exercised by the Imperial Experts over Provincial work. This authority is purely advisory. The Imperial Experts can freely communicate direct with Provincial Experts regarding lines of work already sanctioned, and their advice is also very freely taken advantage of in executive duties.

4. *Tours.*—In 1905 Mr. Sly attended the Educational Conference held at Simla and read a paper on rural education. During the period under report the Inspector-General visited all the Provinces once or several times. The main objects of the tours were to inspect various Government Farms and to confer with the local officers regarding the work done on these Farms, and regarding the extension of experimental work of proved value into local districts and of good methods of cultivation or good varieties of crops into other parts of India. A visit was paid to Burma early in 1905 when a detailed scheme for the organisation of the Agricultural Department of the Province was framed in consultation with the Director. On this tour endeavours were made to ascertain the possibilities of cotton cultivation in the Province. These were not found to be particularly hopeful because the profitable cultivation of cotton requires much labour, and in Burma labour is both scarce and dear. In Madras the Provincial Agricultural Stations and the general agriculture of the Province were seen, and in more particular detail the sugarcane experiments at Samalkota, the Agave plantations at Hindupur and the system of rice irrigation under tanks supplemented by wells. This system can probably be adopted with advantage in many parts of Peninsular India and should be generally known. On

the same tour Mr. Tata's Silk Factory at Bangalore was inspected. Three visits were paid to the Bombay Presidency. The extensive work in the Bombay Agricultural Department was inspected and the possibilities for its extension in numerous directions discussed. The tree cotton experiments made by Mr. Tytler at Belgaum were seen, also the experiments with Egyptian cotton in Sind. The Chharodi Cattle Farm was inspected in company with the Inspector-General, Civil Veterinary Department, and the Bombay Director of Agriculture. It was decided to continue breeding operations on very definite lines and to breed from the very best cattle only. This Farm has been transferred to the Civil Veterinary Department. The Baroda State was visited, and the farms and sericulture experiments there were inspected. In the United Provinces the extensive work initiated by Mr. Moreland in wheat improvement by hybridization and selection was studied, also the general and very varied work of the Department, especially the storing and distribution of good varieties of seed. A conference was held regarding the extension of the Department. The North-West Frontier Province was visited. An area for an experimental farm was selected and general enquiries made as regards agricultural improvements in the Province. On the same tour the Lyallpur Farm and the agricultural conditions of the Chenab Colony in the Punjab were seen. In Bengal Mr. Sly advised regarding the site for the Provincial College and its Farm and also saw the experimental areas under tree cottons which are managed by Messrs. Shaw, Wallace & Co. helped by funds from the Government of India and the British Cotton Growing Association. The agricultural experiments and the general agriculture of the Central Provinces were kept well in review as the head-quarters of the Department are at Nagpur. In February 1906, Mr. Sly went to Eastern Bengal and Assam and conferred with His Honour the Lieutenant-Governor, the Director and Mr. Finlow on the organisation of the Agricultural Department and the cultivation of jute in the Province. He visited with Dr. H. H. Mann, Heeleeka, the principal experimental station of the Indian Tea Association, some tea plantations and the Sisal Hemp plantation at Daurachera.

5. *Board of Agriculture.*—The constitution of the Board of Agriculture, its duties and objects were described in the last Report of the Department. Since then, it has done most useful work in giving advice to Government in general agricultural experimental work and in other connected matters. The Board has now held three annual meetings attended respectively by 32, 35 and 48 members. The increased number of members indicates progress. The influence of these conferences greatly affects the advancement of agricultural science and practice in India. The second meeting of the Board was held at Pusa. It was attended by members from all Provinces except Burma, also by representatives from Mysore and Baroda. The subjects for general discussion

were (1) the programmes of work of the Imperial and Provincial Departments, (2) means of improving Indian wheat and tobacco, (3) the use of artificial fertilizers in India and control of the trade, (4) the provision of fodder for cattle in times of famine, (5) a syllabus for the principal branches of agricultural education. The Proceedings of the Board have been separately published. The proposals as regards the syllabus for scientific agricultural education may have to be modified before they can be accepted for general application. In fact the syllabus as framed for general agricultural education should only be taken as a guide for the agricultural course in any particular Provincial College. A sub-committee consisting of the Pusa staff and several other scientific experts proposed, in general terms, a scheme of experimental work for the Pusa Institute and the Farm. The scheme recommends that fundamental principles applicable to tropical and sub-tropical agriculture only should be dealt with at Pusa. Before we can, however, apply science to practice in the field a complete knowledge of ordinary field practices is required, and it is just as essential to study these practices at Pusa as at Provincial Research Stations. It was decided that the meeting of the Board should, in alternate years, be held at Pusa and in one or other of the Provinces. The third meeting of the Board was accordingly held at Cawnpore in February 1907. In addition to the ordinary members Sir Edward Buck, K.C.S.I., and Major Atkinson, R.E., were visitors, and made valuable contributions to the proceedings. The chief discussions referred to the programmes of work of the various Agricultural Departments, the Indian Sugar Industry, Cotton Improvement, Artificial Fertilizers and the Unification of Laboratory Methods employed by Agricultural Chemists. The question of legislation for the control of artificial fertilizers was again considered. The Board decided that such legislation though desirable is not ripe for introduction, but that trade developments should be closely watched. Sir Edward Buck introduced discussion on two very important subjects. The first was the utilization of river silt in India, the second was the employment of Agricultural Engineers in India. The discussion elicited many facts of general interest. The Board of Agriculture has grown unwieldy as regards the number of members. Its future constitution is being considered. It is proposed to reduce the number of members and to specially invite officers experienced in Agriculture.

6. *The Agricultural Research Institute, Pusa.*—The Director, Mr. B. Coventry, held charge until February 1907, when he proceeded on leave. Dr. J. W. Leather has been officiating for him. All branches of the Institute except Agricultural Bacteriology are now located at Pusa and consist of Agriculture, Chemistry, Mycology, Entomology, Bacteriology and Botany. The Imperial Bacteriologist, Mr. C. Bergtheil, is still on deputation with the Government of Bengal. The general work in

each section is described by the head of that section, and the report of each is added hereto as an appendix. Some reports being lengthy had to be summarised.

The College and Research building are nearly complete and will be opened for work by the end of April 1908. All other buildings are complete; they include eight bungalows for European officers, quarters for six European probationers, a rest-house, hospital, veterinary dispensary, a hostel for seventy students, quarters for thirteen teachers, the farm buildings, general office, temporary chemical, biological, entomological and botanical laboratories, an insectary and a potculture house. The whole estate has been practically cleared of jungle and put in order and the roads and avenues have been greatly improved. The compounds of bungalows and other buildings are in trim order except the compound of the College building which is not yet finished. The Pusa estate, like other parts of Behar, is liable to be suddenly flooded owing to heavy continuous rain. It has, therefore, been found necessary to form embankments to exclude from the experimental areas flooding in occasional years. It is impossible to make full arrangements for the equipment of the Institute until its construction is complete; but nucleus collections for the library and for other sections are being gathered. The museums of economic products, mycology and entomology, will be filled by specimens which have been collected or will be collected in the near future. Until the Provincial Agricultural Colleges are all in working order, we propose to teach at Pusa specially selected agricultural students who will each get a scholarship of sufficient value for support during the course of instruction. The chief object of instruction is to prepare natives of the country for practical work in scientific agriculture. Experienced highly educated natives are not now easily obtainable to supervise field experiments in a reliable way because practically trained men are not available. Eventually Pusa, by giving a post-graduate course, will, it is hoped, produce native specialists in particular lines of agricultural work such as in Agricultural Chemistry, Entomology, Mycology and Agriculture.

7. *Agriculture.*—Mr. E. Shearer, the Imperial Agriculturist, had charge of the Farm and all cultivation experiments during the period under review. The Pusa property extends over 1,300 acres, and the greater portion is intended for work-a-day methods. The clearing, levelling and reclamation of good arable land from jungle is nearly complete and preparations are being made on a small section of the property for scientific experiments which will probably benefit large areas in India. In framing the lines of experiments, the testing of varieties of crops, indigenous methods, available manures and such like, on land similar to that reserved for experimental plots, is likely to lead to useful results and this has been undertaken. In order to prepare for permanent

experiments, the uniformity of particular areas on the farm is being determined. The chief crops grown experimentally were cotton, sugarcane, jute and flax. Exceptional floods damaged the whole estate in 1905 and 1906. Precautions have been taken to prevent this damage in future. A detailed account of jute and flax cultivation is given under separate headings.

8. *Cotton.*—Imported and acclimatised American, indigenous and Egyptian varieties and perennial tree cottons were tried on the farm. After three years' experience general results indicate that many other crops are much more profitable in Behar than any description of cotton. The exotic annual cottons and even the acclimatised perennial tree cottons are liable to severe damage by boll-worm and other pests which are difficult to control.

9. *Sugarcane.*—Twenty-five varieties of sugarcane were planted in 1905. The general results are shortly dealt with in part six of this report.

Green manuring with *Sunn* hemp gave good results on newly broken up poor land. Two pasture grasses, *Chloris virgata* and *Chloris gayana* which flourish in Australia and South Africa were tried and being promising will be tried on a larger scale next year. The pasture area of the Pusa estate is now laid out. Manurial and other experiments on grass and pasture land in England have yielded very valuable and definite results. It has been arranged to start similar experiments at Pusa and to determine whether our pasture land can be improved. Mr. Shearer has framed a scheme of manuring and other experiments which is fully described in the Agricultural Journal of India, Vol. 2, Part 3. Breeding herds of local and Montgomery cattle are kept on the farm, the former with the object of distributing good bulls throughout particular districts in Bengal, the latter chiefly with the object of testing the milking quality of the breed and of supplying the Pusa establishment with milk. Montgomery cattle are probably the best milk-breed in India and apparently can be acclimatised easily in almost any other Indian district. This herd is doing very well at Pusa. The Superintendent, Civil Veterinary Department, Bengal, gives advice and takes a keen interest regarding these breeding herds. The rejection and distribution of bulls for district work is practically left in his hands. We have begun poultry breeding and bee-keeping at Pusa from stocks imported from England, but indigenous stocks will not be neglected.

10. *Agricultural Chemistry.*—Dr. J. W. Leather held charge of the section except during three months' leave when Mr. R. S. Finlow acted for him. He has now a European Assistant. Numerous analyses of soils, waters, silts, manures, feeding stuffs, oil-seeds,

sugarcanes, etc., were made and several special problems were investigated. The miscellaneous work which Dr. Leather has hitherto undertaken will decrease as the posting of Chemists to each Province is completed. He will have more time for original research and for definite large investigations. Such large investigations are now essential because the work of the department has developed. During the period under report Indian commerce has been helped by the work of the Chemical Section. The value of rain and dew in adding manurial elements to the soil is under investigation. Pusa has a well-equipped potculture house which has already given practical results regarding the manures required for particular Indian soils. Dr. Leather has described the potculture house in Memoir No. 3 of 1907, Chemical Series. He is endeavouring to popularise his potculture results by practical application in the field among Behar Indigo Planters. Meteorological records are being kept. Four drain gauges have been constructed and the chemical and other effects of the passage of water through the soil are under investigation. Dr. Leather is determining the conditions under which Cyanogenetic Glucosides are formed in certain agricultural plants, but there are yet no definite results to report.

11. *Mycology.*—The head-quarters of the Imperial Mycologist were transferred to Pusa in November 1905. Dr. Butler's practical work will be greatly facilitated by a complete reference herbarium collection of fungus diseases which affect Indian agricultural crops. The specimens are gradually being collected. His work cannot easily be applied in practice until preliminary enquiries, which take time are worked out. He is single-handed and has more agricultural crop diseases to deal with than in any country in the world. He requires a European assistant in addition to the supernumerary who has been appointed but has not yet joined. Dr. Butler was absent in Europe on leave for three months and then enlisted the co-operation of scientific workers in Paris, Berlin, and Kew. For Mycological work, the training of native assistants has been undertaken at Pusa as far as possible for every Province and will be continued. At Pusa and Poona experiments were continued to study the groundnut leaf disease. The wheat rust problem was also continued. An account of the varieties and distribution of Indian rusts has been published in the Botanical Memoir, Vol. I, No. 2, July 1906. The wilts of pigeon-pea, cotton, gram, jute, sesamum and indigo have also been under study. The knowledge so far gained indicates that the United States Cotton Wilt Fungus (*Neocosmospora vasinfecta*) which is widely distributed in India, is the probable cause. A parasite (*Sclerospora graminicola*) causes the green-ear disease of *bajra*, *jowar*, Italian millets and other cereals. A published Scientific Memoir deals with this parasite (Vol.

II, No. 1 of 1907, Botanical series). In the mycological laboratory numerous specimens of affected agricultural crops, fruit trees, and other economic plants were examined and remedies likely to prove useful were suggested. Field experiments were made at Dehra Dun and Pusa to test the value of soil inoculation recommended by the United States Department of Agriculture. They resulted in no appreciable gains. These methods probably do not generally suit the soils in India because the system of rotation usually practised includes numerous leguminous crops and the bacilli which produce the nodules on the roots of these crops and which add nitrogen in an organic form to the soil are probably numerous in every field. The study of the fungi which help to decompose the organic matter in soil has been commenced. Dr. Butler is giving special attention to the diseases of palm trees, sugarcane and mangoes. The spread of palm-tree disease from the Godavari delta threatens the extinction of palmyra, Cocoanut and betelnut palms in many parts of Madras. Dr. Butler toured through infected areas in August 1905 and March 1907. A large campaign to stamp out this disease is guided by Dr. Butler's advice, and the executive part of the work is being carried out vigorously by the Madras Agricultural Department.

A detailed account of this disease is given in the Agricultural Journal of October 1906 and a technical description of the parasite in the Scientific Memoir, Vol. I, No. 5, Botanical Series.

At Pusa investigation of the "Red Rot," "Black Rot," "Smut" and the "Red Leaf Spot," some of the chief diseases of sugarcane has been made. A simple and efficient method of checking "Red Rot," the most serious of these, has been discovered. The treatment and check of other sugarcane diseases are under investigation.

Dr. Butler visited Malda (Bengal) in 1905 to investigate the disease which is destroying the valuable mango orchards of the district. This enquiry will probably require incricate investigation. Dr. Butler is preparing a text-book regarding the fungus diseases of Indian plants for the use of Indian students.

12. *Entomology.*—Mr. Lefroy held charge of his section during the period under report. A supernumerary Entomologist joined in December 1906. Mr. Howlett as Second Entomologist will take up his appointment in December 1907. He is now specialising in England in preparation for work in India. The work of this section has progressed on very definite lines. The practical results of Mr. Lefroy's enquiries have already been of immense value to India. The entomological work in each Province is carried out by Indian assistants who have been trained at Pusa and who work more or less under the guidance of the Imperial Entomologist. They meet annually at Pusa, discuss with Mr. Lefroy the year's work and compare notes.

These meetings are extremely useful. The time of the Entomologist is largely taken up in identifying insects, reporting on them, and in satisfying enquiries. Steady progress has been made in investigating the life histories of insects injurious to agriculture. Specialists in Europe and America have helped this work. Pusa has now a large reference collection of injurious and other insects. Insecticides fatal to destructive insects but not to domesticated animals have been discovered. The insecticide experiments have reached the stage of field trials. An enquiry has been started regarding the prevalence in India of biting flies and their effects as carriers of disease. This subject is important in medical and veterinary science. The cultivation of Eri silk has been taken up to determine whether the worms can survive the dry hot weather and are likely to be acclimatised to heat in various districts. Lac was also introduced at Pusa as there is a likely field for this industry on existing trees in Behar. A severe outbreak of cotton boll-worm in the Punjab was controlled to some extent by measures described under cotton. Mr. Lefroy and Dr. Butler jointly tested the method of destroying locusts by the fungus which was reported to have been tried with success in South Africa. Healthy specimens of Bombay, North-West migratory locusts and some species of grasshopper were inoculated with pure culture of fungus in various ways. No successful results were obtained presumably because it has been found that the true natural locust parasite in South Africa is a different fungus (*Empusa grylli*) from that which has been distributed from Africa under this name (*Mucor ekiteosus*). A book on Entomology entitled "Indian Insect Pests" has been published. This book gives a summary of the facts relating to insect and insect life, origin of insect pests, their preventives and remedies and refers to the chief pests of the staple crops of India. The book has been widely appreciated in India. Mr. Lefroy is also recording general information regarding the insects of the cultivated areas. This as a text-book will be published soon to help advanced agricultural students and for general information.

13. *Botany.*—Mr. Howard took charge of the office of the Imperial Economic Botanist in 1905. At first he toured to acquaint himself with the agricultural conditions of various parts of India and the Botanical work carried on in the Provinces. A supernumerary Botanist has been added to his staff during the current year. Mr. Howard has in his charge at Pusa a large area which is partly devoted to orchards of many varieties of fruit, and partly to a botanical garden which will be chiefly planted with economic plants. The rest is really a field laboratory in which varieties of imported Indian crops are tested in small plots from which botanical descriptions and other data are obtained. The crops which have been chiefly dealt

with are wheat, barley, flax, tobacco, and fibre plants. Mr. Howard has given special attention at Pusa and in the Punjab to wheat and, I believe, has separated type specimens of all or nearly all Indian varieties from the mixed crops usually grown. This is really the first step towards the improvement of varieties. Cross-breeding and selection, and distribution of seed absolutely true to variety will follow. The general results of Mr. Howard's work with wheat will appear in a monograph which he is preparing and which will be freely illustrated with type specimens of numerous varieties. The study of various kinds of tobacco grown in India was also undertaken. Seed of tobacco was obtained from various parts of India and grown at Pusa. Much of the preliminary classification is now complete, and seed has been collected for further study this year. We have not yet got beyond the field study of varieties of tobacco, but the way has been paved for experiments in curing and also for producing fine qualities of tobacco which may command high prices for export.

14. *Cotton—Survey of indigenous varieties.*—A botanical survey of the cultivated forms of Indian cottons has been practically completed by Professor Gammie, the Bombay Economic Botanist, who has been helped by the Reporter on Economic Products to the Government of India and by experts of the Agricultural Department in each Province. The results have been published in his "Note on Indian Cottons". The report deals with the species and varieties of cotton known in India, their distribution in particular areas, the degree to which hybridization naturally occurs, the quality of lint and other particulars. A revised illustrated classification by Professor Gammie of Indian annual cottons is now in the press and will shortly be issued as a Scientific Memoir of this Department. A provisional classification of perennial or tree cottons found in India has also been prepared by him, but it is not yet sufficiently complete for publication. The Provincial Departments of Agriculture are testing on Government farms the varieties most suited to each cotton tract.

15. *Selection of cotton seed.*—The distribution of seed from selected fields of the varieties ordinarily grown received considerable attention in the Provinces; but this line of work is difficult because every cotton field practically contains several varieties. In India, improvement of ordinary varieties should begin by separating types and can be continued by plant-to-plant selection of seed. This work has been seriously undertaken by the Provincial Agriculturists and Botanists, and will tend slowly but with certainty towards improvement. The only other methods of improvement are (*a*) cross breeding and subsequent selection, (*b*) the introduction of exotic varieties. These methods are being fairly and fully tried. The problem of cotton improvement in India is extremely difficult. Special trade

demands require special kinds of lint. The chief and most paying demand at present is for coarse cotton to mix with wool for the manufacture of cheap warm cloth. If this demand is likely to be permanent, we ought to endeavour to increase the outturn of our so-called "inferior" cottons which are ordinarily grown with profit and without risk. The cotton farms have been extended in almost all Provinces, where it is proposed to raise on a sufficiently large scale for distribution to ryots, seed of such varieties of cotton as have been tried and found successful. A large cotton farm has been started at Surat in the Bombay Presidency for the improvement of the indigenous variety by selection of seed. Attempts to improve the indigenous *Kumpta* variety of Bombay by selection alone appeared to promise well. The various varieties of the Khandesh mixture have been isolated in order to compare the yields and quality of the produce of each. Some 30 tons of seed of the *Lalio* variety selected by the Department of Agriculture, Bombay, were distributed in the Ahmedabad District with successful results. One farm has been started in the Central Provinces for the improvement by continuous seed selection of (1) the coarse *Jari* variety and (2) of the finer *Bani* variety. Efforts have also been made to extend the area of pure crop of the *Karanganni* variety in Madras by special offers of rewards to cultivators.

16. *Cotton Hybridization.*—Experiments are in progress at several centres to improve the superior indigenous varieties by hybridization. The best results have been obtained in Bombay, Central Provinces and Madras. Practical results have been obtained by the Bombay Department of Agriculture by producing three crosses of fixed type which are superior to local cotton and which are suitable for the Surat-Broach tract which hitherto has produced the best cotton exported from India. One of these crosses can, it is believed, be grown over the whole of the Surat-Broach tract and may add immensely to the value of outturn. The other two indigenous crosses with proper treatment are expected to improve considerably. A cross between Bourbon (tree) cotton and Egyptian is also very promising; but requires experimental trial for two or three years longer. In other Provinces cross breeding results are promising, but are not yet sufficiently definite to describe.

17. *Trial of exotic cotton.*—Exotic varieties are under trial on Government farms and in cultivators' fields. Acclimatised American varieties may possibly be successfully introduced on an extensive scale in the United Provinces and in the irrigated areas of the Punjab, but they may in time deteriorate. The seed of *Dharwar-American* was distributed to planters along with seed of *Allens Hybrid* (New American), *Yennovitch* (Egyptian), *Caravonica*, *Broach* and *Buri*.

The trials were unsuccessful, except in the cases of *Dharwar-American* and *Brui*, both of which gave in unfavourable seasons fairly promising results in many places. The latter variety is of American Upland type. It is a fairly prolific and long-stapled cotton and may possibly be found suitable in Singbhum and Sonthal Parganas (Bengal). It gave in the Central Provinces a large outturn of very good cotton, and it will be there tested on an extensive scale. In the United Provinces the acclimatised *Dharwar-American* variety was not particularly successful. The cotton produced was equal to the best Broach, but the outturns were not uniformly good. In order to encourage the cultivation of these exotics which should be sown in the North of India with irrigation before the rains, the canal rate for this crop has been reduced. The cultivation of *American-Dharwar* cotton has increased in the Punjab, in spite of the heavy damage done by boll-worm in 1905. The area under this variety rose considerably in 1906. Experiments with Egyptian cottons indicate that they are well worth further trial in the South-Western districts of the Punjab. A farm has been started in the Province chiefly to grow exotic cottons under irrigation. Egyptian cotton in Sind occupied over 5,000 acres in 1906. The cultivation will probably extend largely, but boll-worm has done much damage. This damage can probably be controlled. The extension of this cultivation is restricted by inferior tillage which will improve as labourers are attracted to these new Canal Colonies, where labour is at present scarce and very dear. In Madras, American, Egyptian and *Caravonica*, varieties were tried, but there were no useful results. In Eastern Bengal and Assam, Spence tree cotton, *Caravonica*, *Dharwar-American*, *King's Improved* and *Buri* have done well on an Upland private estate. *Caravonica* cotton may succeed as a field crop in Assam. The Burma experiments with tree cottons were fairly successful and should be persevered with. The general experimental results indicate that exotic varieties of cotton producing fine lint may be extensively introduced into the Indo-Gangetic plain and particularly into the new Canal Colonies of the Punjab and Sind, provided we can overcome the traditions of the people and the ravages of boll-worm. The latter are more virulent on exotics than on indigenous varieties.

18. *Tree Cottons.*— Experiments with tree cottons are in progress in various Provinces. The results are generally unfavourable. All known varieties previously grown in India have been collected and have been cultivated under various conditions of soil and climate. The numerous varieties, grown on the Poona farm in 1904, were classified by Professor Gammie. The experiments undertaken by a syndicate with Messrs. Shaw. Wallace & Co. as Managers are still in their experimental stage, but this stage has so far been unsuccessful.

I have nothing, therefore, very definite to report regarding perennial cottons, but I am strongly convinced that they will never enter into regular cultivation in India. The British Cotton Growing Association and the Government of India, however, each contributed Rs. 10,000 towards the losses incurred by floods and otherwise on these syndicate plantations. The firm of Messrs. Shaw, Wallace & Co., has transferred their operations to some extent to Mourbhanj, where it is proposed to plant out about 500 acres chiefly with a particular variety of clustered-seed perennial cotton. The best sample of lint of this cotton was valued at 9*d.* per pound. The syndicate have now got about 294 acres under cultivation in different places.

Mr. Tytler, who was assisted by Government in starting a tree cotton plantation at Belgaum had no particular success in his experimental trials (without irrigation). His experiments suffered from the bad season of 1905-06. He has since formed a syndicate for the cultivation of tree cottons on an extensive scale with irrigation at Belgaum. Experiments by Provincial Departments of Agriculture with tree cottons have given conflicting results. *Caravonica* cotton gave promising results in Assam. Experiments have recently been started under irrigation by Mr. Spence at Deesa (Bombay) with a tree cotton which yields superior lint. These trials are in their experimental stage as the trees are yet young. The greatest risk in growing tree cottons is that they are very susceptible to insect pests which once established are difficult to get rid of because the trees are perennial.

19. *Extension of Cotton cultivation.*—The possibility of extending cotton cultivation in India has received a good deal of attention. The area under cotton has considerably increased in recent years chiefly owing to higher prices. The extension of railway systems and particularly of branch lines has materially helped this increase. The British Cotton Growing Association have made a large grant of £10,000 to be spread over four years for the improvement of the quality of Indian cottons and for the introduction and extension of the finer varieties of cotton in India. This grant has been used chiefly in providing seed of good varieties, in safe-guarding cultivators against loss in experimental trials and in obtaining through dealers an adequate price for superior cotton grown by individual land-owners. A sum of Rs. 28,500 was paid as subsidy in 1906-07. Out of this Rs. 10,000 were paid to the Indian Long-stapled Cotton Growing Syndicate to compensate against loss by floods. From the remaining sum of Rs. 18,500, the Provincial Departments of Agriculture spent Rs. 4,025 only during 1906-07. Rs. 10,000 are allotted for expenditure during 1907-08. The Provincial Directors of Agriculture have been consulted regarding the utilization of the grant in future years. Our Agricultural experts in every Province are almost unanimously of opinion that the agricultural

prosperity of India will be benefited less by improving the quality of Indian cottons than by improving the outturn, cultivation and trade practices of the ordinary indigenous varieties. Cotton experiments are likely to greatly expand. A Cotton Expert will be very shortly appointed. He will tour through the Provinces, co-ordinate the cotton experimental work and give in each Province, advice based upon his wider experience gained throughout India.

20. *Tea.*—The Indian Tea Association in its scientific and practical investigations was assisted by a subsidy of Rs. 15,000 from the Imperial Government and with Rs. 13,500 jointly from the Governments of Bengal and Eastern Bengal and Assam. This Department was strengthened by the appointment of an Entomologist (Mr. C. B. Antram), whose head-quarters are at Cachar. He has been provided with a laboratory and insectary. A survey of the tea soils of North-East India has been completed. Experiments have been made to determine the flavour of tea by quantitative analysis. The results have been published as a pamphlet on "Factors determining the quality of Tea." The general characters of many kinds of tea have been studied. The use of green manures and of bones in various forms has been tested in a general way. The different systems of cultivation are under systematic observation. Experiments regarding pruning and plucking promised to give useful results and will be continued till definite issues are obtained. Fungal parasites have been dealt with in a practical way. The causes, the means of infection and of prevention of the disease known as "Blister Blight" of tea plants were ascertained; the results have been published as Bulletin No. 3 of 1906 (Blister Blight of Tea Plant). A Bulletin on the "Mosquito Blight" (Indian Tea Association, Scientific Series, 1905, No. 1), has been published. Other investigations indicate methods of eradicating various insect pests including the "Bark eating Borer," the "Looper," the "Sandwich" and the "Red Slug Caterpillars" and of preventing damage done by "green fly" and the "white ant."

21. *Indigo.*—Scientific investigations were continued and controlled by Mr. C. J. Bergtheil whose services were lent to the Bengal Government for the purpose. The work done is described in appendix A of this report. The improvement of indigo manufacture has received a good deal of attention from specialists and others for many years. Little has yet however been done to improve the plant by selection. The Behar Planters' Association have recently appointed an Economic Botanist. He will have great scope for useful work in systematic field selection and in watching the results of cross fertilization. The superiority of the Java variety under very varying conditions of soil and climate is now generally recognised. There is very little doubt that its cultivation could, with advantage, be greatly extended in India

Mr. Bergtheil in his report of the Indigo Research Station, Sirsiah, 1906-07, however, states that the Sumatrana plant can be grown in Behar on certain classes of soil which are unsuitable for the Java variety. The ordinary field crops grown from Sumatrana or Java seed produce plants of great variety of type. The first step towards real improvement is to isolate type specimens and subsequently determine the economic value of each. As the economic value of a pure type depends upon leaf percentage and indigotin content, it is clear that the field work of an Economic Botanist should be in close touch with chemical laboratory investigations. The importance of an enquiry of this sort and the value of ultimate results to the indigo growers cannot be questioned. Mr. Bergtheil states that a preliminary step has been taken by growing and examining sub-varieties which were identified in 1903. The work of the Economic Botanist will help Indigo Planters when type plants of superior merit are grown and when sufficient seed is available for demonstration areas. The Behar Indigo Planters' Association have established seed farms in Behar. A seed farm has also been opened at Dasna in the United Provinces. The first crop of Java seed was bought by planters at a very high price. Recently at Cawnpore, important tests were carried out to determine the relative dyeing values of synthetic and natural indigo. The results were in favour of the natural product, as regards depth of colour and in other ways. It is conjectured that the impurities in natural indigo have something to do with these results.

22. *Jute.*—Though the area under jute very considerably increased during the two years under review, the demand for the fibre exceeded the supply. Prices remained high. The increasing demand shows the necessity of extending its cultivation outside Bengal. Madras, Burma and parts of Assam appear to offer very favourable physical and climatic conditions for its cultivation. The extension of jute cultivation is being investigated, and preliminary results have been published in Bulletin No. 3 of 1906. Trials with jute were made at the Samalkota Experimental Station (Madras), Ganeshkhind Gardens (Bombay) and at Nagpur and Raipur (Central Provinces). The results at the first two stations were fairly promising. Indigo Planters in Behar took up the cultivation, and their example was successfully followed by their tenants. Extensive tracts in the Assam Valley were for the first time brought under jute and yielded very fine crops. The cultivation is rapidly extending in the plains of Assam, but the lack of labour prevents extensive development. On the Lyallpur Farm (Punjab), jute was also successfully grown this season, but in the Chenab or other Canal Colonies of this Province, scarcity of labour will make extensive cultivation impossible. It has been suggested that the extension of jute cultivation may reduce food supplies for men and cattle in the congested districts

in Bengal and perhaps elsewhere. The experiments on Burdwan and Cuttack Farms clearly indicate that a crop of jute and a good crop of winter paddy can be got from the same field in one year provided the land is sufficiently manured and properly dealt with. Great developments in the jute trade are likely to occur in Burma when the Agricultural Department of that Province gets into full working order which will happen shortly. The crop will also extend largely in Eastern Bengal and Assam and probably in the delta areas of Madras. The scientific enquiries which have been made are described fully in the Agricultural Journal of India, Volume II, Part 2. With the co-operation of Mr. Finlow, forty-four so-called varieties of jute were grown at Pusa with the object of determining their characteristics and to gain knowledge regarding the differences in quality of fibre produced in different districts. Definite results have not yet been arrived at, and the experiments will be continued. A very practical aspect of the jute enquiry relates to improvement of varieties, manuring and cultivation. This is being fully dealt with. In particular, type specimens of each of the numerous races have been separated, and we are now able to supply pure seed of such races as are considered by our Botanists to be distinct. Mr. Finlow and Messrs. Cross and Bevan of London are collaborating in a bacteriological investigation regarding the alleged deterioration of Indian jute, but at present there is no evidence that the plant or its fibre have in any way deteriorated. Deterioration in the fibre is unquestionably due to malpractices in the trade after the crops are grown and retted. The Governments of Bengal and the Eastern Bengal and Assam have declined to undertake legislation to prevent fraudulent adulteration of jute.

23. *Flax.*—The possibility of cultivating flax in India as a paying fibre crop was recently revived by Sir Lewis Hay and the Dundee Chamber of Commerce. The Board of Scientific Advice published a Report on experiments with flax. The subject was referred to in an article issued in Volume I, Part III, of the Agricultural Journal of India. The Dooriah Indigo Factory in Behar, in which Sir Lewis Hay has an interest, carried out experiments which gave promising results. In 1906-07, a quantity of Russian (Riga) seed was distributed through the Department of Agriculture, Bengal. At Pusa and Bankipore, the results were promising, elsewhere they were not. At Bankipore the outturn of green plant was $2\frac{1}{4}$ tons per acre. The Pusa experiments indicated that fibre as well as seed might be profitably obtained in India by introducing the best kinds of Russian, Belgian and Irish seed. At Pusa we have arranged for fibre-extracting machinery suitable for flax. The Government of Bengal made a special grant to the Behar Indigo Planters' Association in 1906-07, to help them to procure the services of an expert from Europe and to instruct them in the methods of steeping, retting,

scutching and placing the fibre on the market. He has been appointed and has arrived. He is engaged in supervising experiments at Dooriah and in giving general advice. (*Vide* appendix B)

24. *Other Fibres.*—The cultivation of Sunn-hemp (*Crotolaria juncea*) and *Hibiscus canabinus* largely increased during the period under report. Formerly they were produced chiefly for use in India, but they are now exported to some extent as substitutes for jute. An investigation regarding possible jute substitutes has been undertaken by Mr. Finlow.

25. *Tobacco.*—Tobacco is a specially important crop in Bengal, Madras and in parts of the Bombay Presidency. Experiments at Pusa and in the Provinces have been undertaken in testing indigenous and exotic varieties, in hybridization and in methods of cultivation. These experiments will gradually lead up to the testing of methods of fermentation and curing. Fairly complete arrangements for these lines of work have been made at Pusa, but I do not anticipate any very special advance in our work until a Tobacco Expert is appointed, as no one in the Department has a specific knowledge of the work which should be done. Some foreign varieties have given good results in growth and apparently also in texture of leaf. Some experiments were conducted by Messrs. Spencer & Co. of Dindigul (Madras) to determine whether Indian grown tobacco could produce a good wrapper leaf when properly cured. The results were not indefinite. The Peninsular Tobacco Company, Limited, have started manufactories at Monghyr and Karachi and are producing cigarettes which, I believe, are superior to those previously produced in India. The fungoid and insect pests of tobacco are under investigation by Dr. Butler and Mr. Lefroy, and a certain amount of advice has been given to Planters.

26. *Wheat.*—The improvement of Indian wheat was fully discussed at the second meeting of the Board of Agriculture. The Provincial experts described the experiments which were being carried out in their respective areas. This information was epitomised by Mr. Howard. Dr. Butler and Mr. Lefroy prepared notes on the fungus and insect enemies of the crop. The Board of Agriculture considered in detail the suggestions and made proposals. The improvement of the Indian wheat trade requires numerous investigations specially as regards facilities for transport and also notably in regard to the separation of varieties, their improvement by selection of seed and by cross-breeding, the provision to cultivators of pure seed of varieties which can be grown without risk and which are suitable for export. The best means of storage in India requires investigation, also the milling and baking qualities of particular varieties. In the Canal Colonies of the Punjab, wheat has been grown year after year on the same land, and this system will certainly become unprofitable in time, even on the highly fertile soil of

these Colonies. The Muzaffarnagar wheat which has been distributed in large quantities from the Cawnpore Farm seed-stores for many years, continues to increase in popularity. In Bengal, this variety has given encouraging results. Pure samples of wheat which are suitable for export are being distributed by Provincial Departments of Agriculture. Rust resistance experiments are in progress on several Government Farms and are everywhere of very great importance. An account of the Indian wheat rusts has been published by Dr. Butler and Mr. J. M. Hayman as a Botanical Memoir, Volume I, No. II of 1906.

27. *Groundnut.*—The most important centres of groundnut cultivation in India are Madras and Bombay. During recent years there has been a marked decline, particularly in the Bombay Presidency in groundnut cultivation and a consequent falling off in the export trade. The causes of the decrease in Bombay cannot be definitely stated but are partially due to a fungoid disease locally known as *Ticca* and also to recent seasons of deficient rainfall. The Imperial Mycologist has shown that this disease which is due both to infected seed and infected soil can be combated by spraying. The chief damage is done late in the monsoon, and therefore early ripening varieties are to some extent exempt. Many foreign varieties have been introduced, and some of these practically escape damage by disease on account of their short period of growth. The most successful introductions in this respect have been Spanish and Japanese groundnuts. The indigenous varieties, however, command a higher price than any one of the Foreign varieties, for reasons which at present are difficult to understand. In Madras, the disease has been so disastrous that a special Government farm has been recently started at Palur in South Arcot for groundnut. There has been a keen demand for sound seed from many parts of the Presidency. Elsewhere also Provincial Departments of Agriculture have distributed sound seed. The groundnut area is rapidly extending in Burma and is likely to expand in the Central Provinces and Bengal and in the irrigated areas of Sind.

28. *Artificial Fertilizers.*—This subject is beginning to attract the general attention of agriculturists in India. It was considered by the Boards of Agriculture and Scientific Advice, and it has been recommended that various Agricultural Departments should undertake experiments to test such manures of this class as are available. A series of experiments are in progress on cotton with various artificial manures, and similar experiments will be extended to wheat, sugarcane and other valuable crops. The Board of Scientific Advice recommended that special attention should be given to the trial of sulphate of ammonia in sugarcane cultivation. This fertilizer is very largely used for sugarcane in Java and Mauritius, both of which countries are importing into India an increasing amount of sugar. When the Tata Iron and Steel manufactur-

ing project is in operation, the output of Ammonia Sulphate will greatly increase and be cheaply available for use in this country. The new artificial manures of Basic Nitrate, Calcium Nitrate and Calcium Cyanamide are under trial and will be tested on several Government Farms, although their prime cost in India for experimental trial is much beyond their worth in practical agriculture. Messrs. Phirozsha B. Petit & Co., Bombay, have, however, proposed to establish a factory in Kashmir for the manufacture of Nitrate of Calcium. At the instance of the Madras Agricultural Department, the Inspector-General of Agriculture referred to the Board of Agriculture at its second meeting, the question whether it was advisable for the Agricultural Departments to undertake the inspection and control of commercial fertilizers in India. Suggestions for legislation on the lines of those adopted in the United States and other foreign countries were also considered. After very careful consideration it was decided that the time was not ripe for the introduction into India of legislation on commercial fertilizers, but the Board considered it desirable to keep special watch over the developments of the trade.

29. *Irrigation.*—This subject, in relation to the improvement of agriculture, was fully discussed by the Board of Agriculture at its first meeting in January 1905 (Items Nos. 23—27 of the Proceedings). In pursuance of the recommendations of the Indian Irrigation Commission, hydraulic experiments in the irrigation of crops have been undertaken in most of the Provinces. In Bengal, the Agricultural Department started hydraulic experiments at Burdwan, Dumraon and elsewhere. These experiments, for the present, have been stopped owing to difficulties connected with reliable supervision. Mr. N. N. Banerji was placed on special duty to enquire into the possibility of extending well-irrigation in Behar and in Chhota-Nagpur. The results of his enquiry have been published as a separate report. The United Provinces have continued the investigations regarding general well irrigation and percolation wells. Well boring experiments are now a permanent feature in the work of the Department of Agriculture of this Province. Government provides the tools and supervision. The land-owners provide labour. Well sinking is also encouraged by giving advances. It is established that perforated cylinders provide the best casing for percolation wells. The Agricultural Department is also making experiments to solve the problem of sinking wells in the rocky parts of the Province and to protect the tracts of deep water level by tube wells worked by a central plant. In the Punjab, hydraulic experiments for irrigating wheat were conducted with the object of (1) determining the least number of waterings required and (2) the quantity of water required in each watering. These experiments will have to be continued for a number of years before definite results can be expected. The local Department of Agri-

culture is considering the question of employing an expert staff to report and prepare maps showing the possibilities of irrigation in each district, to improve the water supply of existing wells, to make trial borings and to generally aid the small proprietors to improve the irrigation of their fields. Hydraulic experiments for irrigating crops have been in progress for some time in Bombay. An oil engine and a pump is at work at the Nadiad Farm in Guzarat. The wells in this tract are deep, and their supplies of water are not easily exhausted. The cost of irrigation by oil-engine and pump is about half the cost by bullock power. The Department has arranged to maintain in each division a small staff of well borers. Boring trials will indicate where wells can be sunk with advantage. It is proposed to place an officer of the Public Works Department on special duty to enquire into the extension of irrigation from rivers by means of oil engines and pumps and to advise and assist land-owners in the erection and management of such machinery. Experiments in boring wells on the Japanese system were carried out in 1905 in the Bhavnagar State, Kathiawar. In all, five borings were made. The Japanese expert well sinker had his implements made locally. The depth reached in one case was 110 feet. The boring implements stuck at a certain depth before water was found and the boring had to be abandoned in each trial. The failure is partly attributed to the difficulty of making the Japanese expert and the labourers understand each other. The total cost of these experiments amounted to Rs. 5,500. Probably better and cheaper results would have been obtained by ordinary boring appliances. Madras has made very useful experiments on an extensive scale in pumping water with oil engines and centrifugal pumps under the supervision of Mr. A. Chatterton, Director of Industrial and Technical Enquiries. His report for 1905-06 fully describes his results. It embodies information in regard to (1) the actual cost of raising water under different conditions ; (2) the amount of irrigation water required under varying conditions as regards crop, soil and rainfall ; (3) the advantage of employing small oil engines and pumps for the irrigation of intensive cultivation such as that of garden crops on small areas ; (4) the quantity of water available for lift irrigation throughout the year from various sources of supply ; (5) the distribution of underground water in various parts of the Presidency and practical means of making larger use of it than at present ; (6) the efficiency of different oil engines and centrifugal pumps, the practical methods and the precautions to be taken in using them ; (7) the general arrangement of installations. In various parts of India *intensive* cultivation is practised and sugarcane, tobacco, ginger, turmeric, and many other crops are grown with extraordinary success. For this *intensive* cultivation, expensive well irrigation by bullocks and ordinary leather bags is very commonly used. This irrigation costs not less than Rs. 100 per acre per annum. The experiments of the last three

years have conclusively proved that there is great economy in using oil engines and pumps if there is a sufficient water supply in the wells. Oil engines can be worked fairly satisfactorily by native drivers on wages of Rs. 10 to 15 per month. In the Central Provinces a series of irrigation experiments with wheat and rice are being conducted on the Government Farms with the object of discovering the duty of water in various classes of soil, the maximum intervals between waterings and the like. In 1906, these Provinces were helped by a grant of Rs. 3,500 from the Imperial Department for experiments with oil engines and pumps. The Burma Agricultural Department is arranging to carry on experiments at Mandalay with irrigated paddy and also with a number of crops grown in the dry zone.

30. *Sericulture.*—Experiments in sericulture are in progress in several Provinces. The Bengal Silk Committee, with the support of annual subsidies from the Governments of Bengal and Eastern Bengal and Assam, continued to do useful work. Several model-rearing houses have now been constructed by the Committee. Microscopes and disinfectants were distributed to rearers. The necessity for these is gradually being appreciated by rearers particularly in Birbhum. The principal firms interested in the silk industry made a representation to the Government of Bengal showing a marked decline in the industry. A small Committee was appointed to make inquiries, and certain remedial measures were suggested. The late Mr. N. G. Mukerji, known as a Silk Expert, was deputed to Kashmir and Bangalore to report on methods of rearing, reeling, etc. He returned with the belief that the Bengal system of reeling could not be much improved and that inferiority in quality of silk was due to inferior cocoons. He was also deputed to the Baroda State, where Mulberry silk experiments have recently been started. After enquiry in the Central Provinces he also made recommendations for the improvement of the Tussar silk industry in that province. Sericultural experiments in the rearing of Univoltine silk in Eastern Bengal and Assam have, for the last three years, been giving successful results. In Hoshiarpore (Punjab) there has been a small but successful experiment. The raw silk produced in Kashmir in 1905 yielded a very high profit of £28,139 or 58½ per cent. on invested capital. The profits of 1906 are expected to exceed those of the previous year. The Kashmir industry gives employment to nearly 70,000 persons. A great success has already been achieved in establishing the silk industry at Mustang in the Kalat State (Baluchistan). The silk produced is equal in quality to Kashmir silk. Experiments in rearing Eri silk were started by the Imperial Entomologist at Pusa. Between April and November, five broods aggregating 150,000 worms were fed on the leaves of castor plants. The silk produced was valued in Calcutta at Rs. 80 per maund.

31. *Agricultural Education.*—The scheme sanctioned by the Secretary of State for higher agricultural education provides for seven Provincial Agricultural Colleges. In each of the larger Provinces except Eastern Bengal and Assam a site has been selected, land for experiments acquired and considerable progress made in construction of buildings. In most Provinces, the Colleges will be in working order within the next two years. The Madras College will be established at Coimbatore and the Bombay College near Poona. The Agricultural Schools at Nagpur (Central Provinces) and Cawnpore (United Provinces) will be each raised to the status of an Agricultural College. The needs of the Punjab and the North-Western Frontier Province will be met by a new Agricultural College at Lyallpur. The Agricultural Branch of the Sibpur (Calcutta) Engineering College will be closed as soon as the new Agricultural College at Bhagalpur is ready. The Burma Agricultural College is being built at Mandalay. The provision of Provincial Agricultural Colleges has modified the original aim of the Pusa Agricultural College. It will provide a post graduate course extending over two years to qualify graduates of Provincial Colleges as Experts in specialized branches of Agricultural Research. Pending the completion of the provincial Colleges selected students have been sent to Cambridge and America to complete their higher training in Agriculture. Four Bombay students are specializing in Sciences connected with Agriculture at Cambridge. Similarly the Government of Bengal have sent six students to America to graduate in Agriculture and specialize in particular lines of Agricultural work. Twenty-two probationers from various Provinces were under training at Pusa. Some were found unfit and rejected. Thirteen completed their training and were qualified for Provincial service. Three were trained in general agriculture, two in Agricultural Chemistry, two in Mycology and six in Entomology. Two probationers are still under training in Agriculture and Mycology. Besides these, six men were trained for field work in Entomology and one in Entomological drawing. The most pressing requirements of Provincial Departments are thus met; but the real development of agricultural improvement hinges on the completion of the Provincial Agricultural Colleges and the Pusa Institute. When these are ready, arrangements will be made to give full agricultural training, and the necessity of sending students to foreign countries will cease. Questions relating to educational qualifications necessary for admission, scholarships, the curriculum of studies and the degree to be conferred on passed students have practically been settled.

32. *Distribution of seeds and implements.*—This branch of work engaged much attention during the past two years. The demand for pure and selected seed has increased, and a number of seed depôts have been started by the Provincial Departments of Agriculture. The distribution has not, however, been successful in all directions particularly in regard

to indigenous varieties of cotton. For distribution in the Central Provinces cotton seed was obtained from particularly selected fields of good crop, but this selection was really no selection at all, because every field in the Central Provinces grows a very mixed crop of cotton. We have to begin much more humbly, go slow and be quite sure that we are really distributing seed which is true to a particular type. This principle is the beginning of seed selection, and the sooner this is fully recognised in every Province in India, the better for the country. In some of the other Provinces, the cotton seed distributed was truer to kind. Besides cotton, seed of other crops such as wheat, ground-nut, jowar, jute, tobacco, indigo, mustard, etc., was distributed to Government Farms or private persons, the object being to introduce new and superior varieties. Mention may be made of the successful results obtained at the Dumraon Farm by the introduction in 1902 of Jubbulpore and Raipur mustard. These varieties have been found superior to the local variety not only in the quantity of yield but also in the quality of oil. The Provincial Agricultural Departments have mostly established seed farms on a sufficiently large scale to grow seed of such varieties of crops as have been tried and found successful. We have had numerous indents from foreign countries for seeds and plants, and we get an adequate return in kind. We have sent abroad, in small parcels, a total of nearly four tons of seed during the last two years.

The interchange between Provinces of superior indigenous implements was as satisfactory as in the previous years. The agricultural exhibitions and shows which are becoming important features of the Provincial activities have greatly helped this work. There has been a marked increase in the demand for iron ploughs in some of the Provinces; winnowers and fodder cutters are gaining favour among cultivators. The Poona sugar boiling apparatus and the plant used in Mr. Hadi's process of sugar making have become widely known to cultivators, and the demand for these is steadily increasing. The merits of new implements are fully tested on Government Farms, and demonstrations are made to show the advantages of those which suit local conditions. Owing to scarcity of labour in the Canal Colonies of the Punjab, bullock-power reapers and steam threshers are coming into use, because, the enormous irrigated wheat crop of these Colonies must be handled expeditiously.

33. *Publications.*—At the suggestion of the Board of Agriculture of 1905 (Item 43 of the Proceedings) the Annual Reports of the Experimental Farms and the Departments of Agriculture have been improved. These reports will be issued hereafter in uniform size and at uniform dates. The work of each experimental station will be described in the form of a continuous record which will include any positive action taken to make the station and its teachings known to agriculturists generally. Accounts of experiments which have yielded very definite

results in experimental plots and demonstration areas will be published in Bulletin form. These Bulletins will be translated in simple vernacular for the information of native cultivators.

The Imperial Department of Agriculture now issues two important publications (1) the Agricultural Journal of India—a quarterly Journal, intended for the use of educated Indian Agriculturists and general readers interested in agriculture, and (2) the Scientific Memoirs of the Department of Agriculture, which are papers of a scientific or technical nature and are published occasionally. These publications are widely distributed in India and to learned societies and interested individuals in all countries. The free distribution is more extensive than the sale list. An adequate return is, however, obtained in free copies of publications which are indispensable to the Department. Moreover, advertisement is essential for new publications. The Journal and Scientific Memoirs are liberally supported by contributed articles from the Imperial and Provincial Experts of the Department and also from other Government officials and private individuals. Articles on original work in India can be published quicker in the Memoirs than in any home journal. This is a matter of importance to scientific men working for the Indian Agricultural Departments and is fully appreciated. A good many Bulletins have been published during the year by the various Agricultural Departments. They deal with definite results of agricultural experiments. All the agricultural publications issued in India during the past two years are given in the list of publications (Appendix C).

34. *Expenditure.*—The expenditure incurred in the Imperial Department of Agriculture (apart from expenditure on buildings constructed by the Public Works Department) has been as follows :—

Section of Department.	1906-07.	1905-06.
	Rs.	Rs.
Inspector-General of Agriculture in India . . .	90,235	1,03,360
Director, Pusa	1,06,300	60,665
Chemical Section	28,268	28,694
Mycological Section	25,382	24,055
Entomological Section	28,588	32,056
Bacteriological Section	2,500	900
Agricultural Section	99,248	63,692
Botanical Section	19,743	21,503
TOTAL .	4,00,264	3,34,925

The figures for 1905-06 include Rs. 99,572 for the initial expenditure under the following heads :—

	Rs.
Construction of Departmental Buildings and Machinery	50,747
Equipment of the Pusa Library	18,825
Laying out roads	15,000
Irrigation	15,000
TOTAL	99,572

Deducting this amount from Rs. 4,00,264 we get a net recurring expenditure of Rs. 3,00,692 for 1905-06. The expenditure of 1906-07 is larger than that of 1905-06. The increase in 1906-07 is due to the expansion of the Department. In addition to the ordinary budget provision, the Inspector-General of Agriculture in India receives an annual grant for expenditure upon special investigations, improvements and the like, which he may desire to introduce. The principal objects to which this grant has been devoted in the past two years are as follows :—

Particulars.		Amount.
1. Grants-in-aid of long stapled cotton experiments by Messrs. Shaw, Wallace & Co.		Rs. 40,000
2. Grants-in-aid of the Department of Agriculture, Bombay		12,000
(1) For Mr. Tytler's cotton experiment at Belgaum	5,000*	
(2) For Sugarcane Power Crusher for Manjri Farm	5,000	
(3) For sugarcane experiments in Sind and for demonstration of improved Poona method of *gul* making at the Ahmedabad Exhibition	1,200	
(4) Contribution to the Nadiad Farm	800	
3. Grants-in-aid of the Department of Agriculture, Bengal, for distribution of seed of the *Aus* variety of Central Provinces paddy in the Chota Nagpur District		350
4. Grants-in-aid of the Department of Agriculture, Central Provinces, for expenditure upon experiments with an oil engine and a pump in the Central Provinces		8,200
5. Paid to the Secretary to the Chief Commissioner, Coorg, for agricultural improvements in Coorg and for experiments with Caravonica cotton		3,000
6. Grants to the Indian Tea Association		30,000
7. Purchase of seeds, implements and other requirements for agricultural experiments		2,680†
8. Extension of Botanical Garden at Pusa		4,000
TOTAL		1,00,230

* Recovered from Mr. Tytler owing to his having formed a syndicate.

†The main heads of expenditure under this item are (1) Supply of jute seed to the Colonial Office, London, for trial in West Africa; (2) Purchase of Arlington ploughs for trial in India; (3) Supply of Indian cotton gins to the Crown Agents for Colonies, Whitehall Gardens, London, for transmission to Lagos; (4) Purchase of sugar boiling pans, for trial in the Central Provinces; (5) Purchase of Hodgkinson's cotton hand-gins for trial; (6) cost of date palm off-sets and tree cotton seeds; (7) Sugarcane cuttings supplied to Samalkota Experimental Station.

35. *Provincial Departments of Agriculture.*—It is unnecessary to give details of work done in each Province because each Department publishes its own report. I may, however, give the following information.

36. *Bombay.*—The Department has five European Experts, a large staff of well-trained Indian assistants, an Agricultural College and

twelve experimental stations. The College is at present the only one that teaches up to a degree standard in Agriculture. It is at present located in a hired bungalow. The classes for the three years' course are large. The permanent building for teaching and research work is being built. One hundred and forty-three acres of land have been acquired for the College Farm. An Industrial and Agricultural Exhibition was held at Surat in 1906. The Department sent 722 exhibits. The Department holds annually an Agricultural Conference chiefly to obtain the views of practical business men regarding agricultural improvements. The Conference was held in Bombay in 1905, in Surat in 1906 and will be held at Ahmedabad in November 1907. Similar conferences if held regularly in other Provinces would also be of great value.

37. *Madras.*—The Expert European staff of the Department now consists of the Principal of the College, an Agricultural Chemist, Economic Botanist and two Deputy Directors of Agriculture. Mr. Chatterton, Director of Industrial and Technical Inquiries, helps the work of the Agricultural Department in many ways. His long experience in India is invaluable. There are now ten experimental stations in Madras which are devoted to general agricultural problems, also to particular enquiries regarding sugarcane, pepper, jute, groundnut, agaves, rice and cotton. Groundnut has received prominent attention, and there is a high demand for sound seed. The need is felt for practical Indian subordinates who can properly supervise field work. The new Agricultural College and the head-quarters of most of the expert staff will be at Coimbatore. Agricultural Shows and Associations are a marked feature in the useful work of the Department.

38. *United Provinces.*—The Director, Mr. W. H. Moreland, C.I.E., after a visit to Australia began the first work in wheat improvement by cross-breeding in India. This work continues to be a very important enquiry in his Department. His expert staff of European specialists is being gradually recruited, and the old Cawnpore School of Agriculture is advancing to the status of a college. Four agricultural stations are now at work, and the Province has been mapped out into four divisions, to each of which an all-round agricultural expert will be appointed. The methods adopted for storing and distributing good seed of particular crops could, with great advantage, be carried out in other Provinces. The method devised by the Assistant Director, Khan Bahadur H. M. Hadi, M.R.A.C., for refining sugar, has attracted much attention. Boring experiments for well water have been very successful. A superior method for constructing percolation wells has been devised.

39. *Bengal.*—The work of the Department of Agriculture was separated from that of Land Records towards the end of the year 1905-06. The expert staff sanctioned for this Province consists of Deputy Director of

Agriculture, Principal of the College, Economic Botanist and Agricultural Chemist. The last two places are still vacant. Indian assistants trained at Pusa have been appointed for such Entomological and Mycological work as can be done by them under the guidance of the Pusa staff. There are six agricultural stations at Dumraon, Burdwan, Sripur, Cuttack, Bankipore and Sabour near Bhagalpore. The first three stations are maintained at the cost of the Dumraon, Burdwan and Hathwa Rajs, respectively. The Bankipore (210 acres) and Sabour (340 acres) Agricultural Stations are being organised. A farm of 200 acres will be opened at Chinsura on the East Indian Railway line for the deltaic alluvium. The Department has opened a seed, implement and manure store which is increasing in usefulness. It is proposed to open such stores at each Agricultural Station. A Committee, with the Director as President, was appointed to enquire into the present decline of silk industry and to suggest remedial measures. The improvement of jute as regards agricultural and trade aspects has received much attention by the Department. The cultivation of imported varieties of flax is likely to lead to a new profitable fibre industry. The value of the *Rhea* industry which was boomed in Bengal some years ago, may now be discounted. The Bengal Government has continued to make an annual grant of Rs. 50,000 to the Behar Indigo Planters' Association for research work in indigo. The services of Mr. Bergtheil have been placed at the disposal of the Association. A very short summary of the research work done by him and his assistants at Sirsiah is given in Appendix A. The details of work done cannot be conveniently described here, but I consider that Mr. Bergtheil should continue his present investigations when he takes up his permanent appointment at Pusa and also as far as possible guide by advice the scientific work of the Behar Planters' Association. Pending the completion of the Provincial and Pusa Colleges, the Department has sent six passed students of the Sibpur College to America for higher agricultural training. The report of the progress of these students is satisfactory.

40. *Punjab.*—A separate Department of Agriculture has been formed in the Punjab as in other Provinces. The expert staff at present consists of the Principal of the Agricultural College and Research Institute, the Deputy Director of Agriculture and the Agricultural Chemist. An Economic Botanist will join shortly. The extraordinary fertility of the new Canal Colonies and the enterprise of the cultivators offer exceptional chances for agricultural improvement. The Punjab agricultural experts have thus unusual opportunities of improving the agriculture of the Province. The scarcity and dearness of labour in the Punjab will probably require the introduction of labour-saving machinery for the wheat crop. There are very large exports of wheat from the Punjab, and prompt harvesting and disposal of the crop is very important,

I suggest that it is extremely important that railway and other facilities for export should be improved.

41. *Central Provinces.*—The Department of Agriculture is now separated from that of Land Records and Settlements. Two Deputy Directors of Agriculture, an Agricultural Chemist, a Principal of the College and an Economic Botanist have been sanctioned. There are four experimental farms at Nagpur, Raipur, Hoshangabad and Akola. The Nagpur Farm deals chiefly with cotton, wheat and rotation experiments and the Raipur Farm with rice. The Hoshangabad Farm is specially intended for wheat experiments and the Akola Farm for experiments with cotton. The Department has particularly demonstrated in the districts the advantages of drilling particular crops and of using particular implements, specially winnowers, chaffcutters, iron-ploughs and sugar-making appliances. A good deal of useful work has been done in the sanitary disposal of sewage on cultivated fields on the Meagher System. The method of applying sulphate of copper to juar (*Sorghum vulgare*) seed to prevent smut has been extensively demonstrated. The distribution of selected seed was extended. The Nagpur Agricultural School has been raised to a College with a three years' course. The Agricultural Gazette which is published in vernacular has maintained its circulation. Several Agricultural Associations have been formed.

42. *Eastern Bengal and Assam.*—The expert staff of the Department consists of the Assistant Director and the Fibre Expert. The posts of Economic Botanist, Agricultural Chemist and the second Deputy Director of Agriculture have been sanctioned, but are not yet filled. The College and Laboratories are under construction at Dacca, and land has been acquired for a College Farm. The experimental stations are at Rangpur, Rajshahi, Jorhat, Upper Shillong and Wahjain, and land for a tobacco station at Burihat is being acquired. Important jute experiments are in progress. Bengali cultivators, to demonstrate the proper method of cultivation and of extracting the fibre, have been employed. The Rajshahi Sericultural School has been taken over by Government and remodelled on a popular basis.

43. *Burma.*—The Agricultural Department has now been fairly organised. The Land Records and Agricultural Departments have been separated. The expert staff consists of an all-round Agriculturist, as Principal of the College, Deputy Director of Agriculture, Agricultural Chemist and Botanist. Arrangements have been made to start three agricultural stations—one at Mandalay as College Farm, one at Hmawbi chiefly for the study of paddy and a third in the dry zone of Burma.

44. *Expansion of the Department.*—The general expansion of the Agricultural Departments in India outlined in the last report has progressed. The experimental stations and demonstration plots in each Province have increased in number. I have already referred to the strength-

ened staff of European Specialists. I am hopeful that the Indian staff will be improved by better rates of pay and prospects. The work of the Department will be much extended by the Provincial Agricultural Colleges, Agricultural Associations, Agricultural Shows and the establishment of cattle-breeding farms. Efforts are being made to provide improved seed, good manures and better implements. In the Provinces, the Departments of Agriculture have been separated from the Departments of Land Records in order to enable the Directors to devote undivided attention to the improvement of agriculture. There is, in fact, a general advance which need not be further particularised, but which is an advance for progress.

J. MOLLISON, M.R.A.C.,
Inspector-General of
Agriculture in India.

SIMLA, E.,
The 17th October 1907.

LIBRARY OF THE BOMBAY BRANCH OF THE ROYAL ASIATIC SOCIETY

REPORT OF THE OFFICIATING DIRECTOR OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA

1. *Charge of Office.*—Mr. B. Coventry held charge of the office of Director until February 20th, 1907, when he proceeded on leave and I was appointed to act for him in addition to my own duties.

2. *General work of the Institute.*—The Institute consists of six sections, namely, Agriculture, Chemistry, Botany, Entomology, Mycology and Bacteriology. The agricultural, entomological and botanical sections have been located at Pusa during the whole two years; the chemical and mycological sections were transferred from Dehra Dun in 1905; whilst the bacteriological section remains to be opened. Excepting Agriculture, the sections which are already at Pusa are accommodated in temporary buildings pending the completion of the new laboratories. The nature of the work is fully explained by myself and my colleagues in the following sectional reports.

The extensive laboratories which have been under construction for three years will be ready for occupation by the end of April 1908.

3. *Buildings.*—Quarters for the European and native establishments, students' hostel, rest house, hospital and veterinary dispensary have been completed. The Farm buildings, Farm Office, Botanical and Entomological minor laboratories, Insectary, Fumigating House, and Potculture House were constructed departmentally.

4. *Roads, etc.*—The estate is liable to inundation from two sides and during the monsoon of 1905 and 1906 a large area of land was under water on this account. Three protective embankments became necessary, two of which have been completed and the third will be so shortly.

The roads of the estate have been made. The avenues have been thinned or new trees planted where necessary and generally improvements introduced. In some cases areas of jungle have been cleared for cultivation and pasture land.

Most of the compounds of the completed buildings have been laid out, but that of the large laboratories cannot be dealt with until the building is completed.

5. *Medical.*—A Military Assistant Surgeon was appointed in September 1906 but reverted almost immediately to military duty. He was succeeded by Mr. J. R. Foy in November 1906. The average number of cases in hospital has been 2·66 per day since the hospital was opened and the average number of out-door patients has been 13·11. In the

opinion of the European staff at Pusa the present medical arrangements are unsatisfactory.

6. *Training.*—Some students have undergone periods of training in special subjects. The courses of instruction will be much amplified when the Institute laboratories are complete.

7. *Library.*—The Library of the Institute consists of about 4,000 volumes, many of which are very valuable. It has been arranged to lend books to officers of the provincial departments under certain conditions. The catalogue is about to be issued.

8. *Publications.*—The publications of the Institute comprise (1) The Agricultural Journal of India, published quarterly, (2) Scientific Memoirs of the Department of Agriculture in India, (3) Bulletins which deal with matter in process of investigation, (4) Leaflets in English or the vernacular are issued at intervals.

The Inspector-General of Agriculture in India is the Editor and is assisted by advice from the staff. The grant is Rs. 25,000 per annum.

The preparation of these publications takes up much time. The Artist's work is supervised by Mr. Lefroy and the Photography is in my charge. These duties are by no means nominal and absorb much time. An Assistant Editor is urgently required.

9. *Accounts.*—The whole of the accounts pass through the Director's office. The total current cost of the Institute may be summarised as follows :—

	1905-06.	1906-07.
	Rs.	Rs.
Pay and travelling allowances	1,16,500	1,31,900
Publications	15,000	25,000
Farm expenditure and Scientific apparatus buildings, sanitation, etc., and contingencies . . .	1,78,500	74,700
TOTAL .	3,10,000	2,31,600

J. WALTER LEATHER,
Officiating Director, Agricultural Research Institute, Pusa.

REPORT OF THE IMPERIAL AGRICULTURAL CHEMIST FOR THE YEARS 1905-06 AND 1906-07.

1. *Charge of Office.*—I held charge of this branch of the Institute until April 11th, 1906, when I proceeded on privilege leave until July

2nd and Mr. R. S. Finlow officiated for me ; I again held charge throughout the following 12 months.

2. *Laboratory.*—The laboratory was transferred from Dehra Dun to Pusa in November 1905 where it has been accommodated in a temporary building pending the completion of the permanent laboratory.

3. *General analytical work.*—In past years a large part of the energies of the establishment have been absorbed by the examination of specimens sent by provincial departments. With the appointment of provincial chemists a material change has been effected in the character of the work undertaken, and investigations of a more special nature have been taken up.

The following statement shows the number of samples analysed in each of the two years :—

	1905-06.	1906-07.
Soils	244	255
River water and silt	..	82
Waters	65	65
Manures	229	124
Feeding stuffs and oil-seeds	63	51
Sugars and surgarcane	46	132
Plants examined for glucoside	..	40
Rubbers	9	..
Gum	1	..
TOTAL	657	749

4. *Potculture House.*—A very well-equipped house for experiment on plants and soils by potculture methods has been erected at Pusa and a description of it published as Memoir No. 3 of the Chemical Series. The nature of the work carried on here is explained in paragraphs dealing with plant food in soils and cyanogenetic glucosides.

5. *Available plant food in soils.*—For sevefal years a good deal of attention has been given to a study of available plant food in soils. The earlier work consisted in comparative tests of the validity of Dyer's method for the estimation of a soil's requirements in phosphates or potash and the principal results obtained have been published as Memoir No. 4, Chemical Series. As a practical adjunct to this work, a series of field experiments on the value of superphosphate in Behar, where the soil seems to be generally, within certain geological limits, deficient in available phosphate, has been commenced.

The investigation on available plant food in soils has more recently been directed to a more exact knowledge of the precise state in which

these compounds exist, in the hope that more accurate methods of soil examination may be evolved.

6. *Pusa soils.*—In 1906 samples of the surface and sub-soils of all the fields within the arable area at Pusa were taken ; they were subsequently analysed and, in addition, specimens of each were stored for possible future examination.

7. *Meteorology.*—The usual meteorological records are maintained and the Institute is a reporting station of the meteorological department.

8. *Rain and Dew.*—A record of the amount of Nitrogen compounds in rain and dew was maintained last year at Pusa to provide a confirmation of that which was obtained by the examination of rain water and dew at Cawnpore and Dehra Dun (Memoir No. 1, Chemical Series) and the newer data agree with these in demonstrating the smallness of the total amount of these compounds in the annual rain and dew.

9. *Drain gauges.*—During the hot weather of 1906 four gauges were constructed at this Institute for observing the nature of percolation during wet weather. They are similar to those at Rothamsted in England and at Cawnpore and each consists of a block of earth 1—1000 acre in area which has been isolated in the undisturbed state. In two, the earth is three feet deep, and in the other two it is 6 feet deep. Rain water falling on them may either soak into the soil, or if the fall is very heavy it may also overflow. Arrangements are made for measuring the amount of water which percolates, the velocity of percolation, the chemical characteristics of the drainage water, and for measuring any water which overflows at 2″, 3″ or 4″ above the ground level, as may be desired. The construction was carried out by Mr. M. H. Arnott, Superintending Engineer, Public Works Department, to whom we are much indebted for the care and interest that he devoted to this work. We shall thus have two records in India regarding the nature and quantity of percolation. Of those at Pusa it is proposed to keep one six-foot and one three-foot gauge entirely bare fallow, and on the other two vegetation, either grass or other plants, throughout the year, in order to determine the difference between the amount of drainage in the two cases.

10. *Loss of water from soil.*—Information as to the rate at which water is lost from soil during periods of dry weather and the amount of movement through the soil naturally forms the counterpart to a knowledge of drainage conditions, and records have been kept, in the first instance in bare fallow land, for this purpose. The first year's results have been considered of sufficient interest to merit publication and will appear shortly.

It will be evident that information regarding the movement of water through the soil during wet and dry weather respectively in India, important as it is when considered alone, is enhanced by the fact that it at the same time assists the formation of an opinion as to possible movements of plant food through the soil.

11. *Saltpetre.*—A reference was made in my last report to the saltpetre industry. Experiments were made to ascertain the manner in which the salts are removed from the nitre-earth during the percolating process so universally employed, and these demonstrated that the nitrates and chlorides pass out first, the major part of the sulphate remaining, in the ordinary course of the work, in the soil; and that the effect of the ashes which are so commonly added is to convert some of the nitrates of soda and lime into the potash salt. It was also ascertained that the common belief in the formation of nitrate in the refinery earths has no foundation in fact.

12. *Sugarcane.*—An assistant of this laboratory was again deputed during 1906 to analyse sugarcane in the Balaghat district.

The composition of the juice of the varieties of sugarcane at Pusa has been ascertained each year, and latterly this has been done periodically during the whole ripening period in order to ascertain what changes occur at this time.

13. *Cyanogenetic glucosides.*—Various plants, jowar, linseed, have been grown under varying conditions in order to try to determine the conditions under which their peculiar cyanogenetic glucosides are formed in large amount. It has been found that this is not a feature of the variety, for instances of the same variety forming much glucoside, or none at all respectively, have been met with. It is hoped that by carefully controlling the conditions of growth, the cause of formation may be isolated, and the work has met with a certain measure of success.

14. *Establishment.*—Mr. H. E. Annett, Supernumerary Chemist, arrived in May 1907. Mr. W. Roberts, Supernumerary Agriculturist, has been detailed to this section for experimental work on Behar soils. Four of the Indian assistants, who have served for some years in this section, are doing good work. Four of the provincial chemists spent some months at Pusa in order to acquaint themselves with the general work which is in progress.

In December 1905 three probationers, one each from Bengal, Madras, and the Central Provinces, were sent to this Institute for a period of training in the chemical section. Of these one resigned; the other two

remained until March 1907 and then returned to appointments in their respective provinces. The sanctioned scale of pay is insufficient to secure the best men, and only attracts probationers possessed of very limited qualifications. Much more than this is required if any particular progress is to be made in Agricultural Chemistry in India.

J. WALTER LEATHER,
Imperial Agricultural Chemist.

PUSA.

PART IV.

REPORT OF THE IMPERIAL MYCOLOGIST.

1. I held charge of my section during the period under review, with the exception of three months from the 9th of August 1906, when I took privilege leave and Mr. S. K. Basu, Senior Assistant, took charge.

My laboratory was transferred from Dehra Dun to Pusa, in November 1905. It now occupies a temporary building. Considerable difficulties have been caused by damp and dust. Though these will be largely obviated when the main building is ready for occupation, still the experience of the past two seasons has shown that certain classes of work will always be carried on at a disadvantage in the warm, moist climate of Pusa.

My section will have two distinct functions to fulfil. One, common to all similar sections of Agricultural Departments everywhere, is the investigation of plant diseases and the study of fungi concerned in them, or otherwise agriculturally important. The other, usually separated or, indeed, in the older departments often unnecessary, is the accumulation of a representative collection of fungi for consultation. A large general fungus herbarium is not usually considered a necessary part of the equipment of an agricultural mycologist's laboratory. Such a collection is generally available elsewhere and in cases of difficulty the services of competent systematists near at hand can be obtained for the identification of species. As a matter of fact, however, in Europe at least and in a measure in the United States, cases of difficulty rarely arise. The fungus flora of these areas is well known and the identity of the species parasitic on particular plants can be determined with considerable ease. In India circumstances are different. It is probably the least known, excepting China, of any large area in the civilised world as regards the fungus flora. Almost the only important group of parasitic fungi which has been studied in India is the "rusts". Hence, though many of the commoner crop diseases of Northern India are known and have been studied in Europe, cases constantly occur of diseases which have not been previously investigated. In order to deal with these it is necessary to have the means of identifying the parasites concerned. The co-operation of other workers is not always available, and though I have to acknowledge generous assistance from outside India it is essential that the Mycological section at Pusa should eventually reach a position in which it will be able to deal with work of this nature. Further, one of the important duties at Pusa will be to assit

other Mycologists in India in determining their species and forthis purpose good consulting collections are necessary.

Much time has been given to organising the sectional library and collections for ready reference to meet this demand. Card indices of the collections both parasites and host plants, and of all fungi hitherto described from India, have been prepared.

When on leave in Europe, I visited Kew, Paris and Berlin to secure assistance in naming and describing my collections of Indian fungi. I was fortunate enough to obtain the co-operation of Messrs. H. and P. Sydow of Berlin, and technical descriptions of Indian fungi will appear from time to time in their Journal, the " Annales Mycologici ", one of the chief organs of systematic Mycology.

During the period under review, I collected specimens in Central Bengal, Behar, Godaveri, Belgaum, Bassein, Kumaon and Lyallpur. A very useful collection was made by Mr. S. N. Mitra, 3rd Assistant, in parts of the Bombay Presidency. Munshi Inayat Khan collected in Bundelkhand and Kumaon. Specimens have been presented by Mr. I. H. Burkill, Mr. J. M. Hayman, Mr. C. A. Barber, Professor Gammie, Mr. Sundararaman, Mr. R. S. Hole, Mr. R. S. Troup, in India and by Dr. Walter Busse, Berlin, Mr. E. W. Holway, University of Minnesota, Mr. C. G. Lloyd of Cincinnati, Professor Jakob Eriksson, Stockholm, and Herr H. Sydow, Berlin, to all of whom I am much indebted.

The main lines of research work which it is proposed to follow at Pusa, were submitted to the Committee of the Board of Agriculture appointed to advise on the scientific work of the Institute at the second meeting of the Board held in January 1906, and were approved of.

2. *Investigations of Plant Diseases.*—Palm diseases. A serious disease of cultivated palms has broken out within the past few years in the Godaveri Delta. It is spreading slowly in a continuous area. Palmyra palms are chiefly attacked, but coconut and probably betelnut palms are also destroyed. In many villages over eighty per cent. of the palms have been killed. I visited the diseased area in August 1905 and March 1907. Proposals were made for an organised campaign to endeavour to stamp it out before the very valuable coconut forests further south were infected. A sum of Rs. 5,000 was sanctioned by the Madras Government, in 1906, for experimental measures for its control in a small area. This was increased by Rs. 26,000 in 1907, for the treatment of the whole area affected. The present operations are under the control of an Assistant Collector with a supervising staff from the Madras Department of Agriculture and two assistants from Pusa. The working parties are composed of palm climbers (toddy drawers) under several Revenue Inspectors. The cause of the disease is a fungus which chiefly attacks the leaf sheaths, and spreads gradually through

successive sheaths until the central bud is reached and the tree is killed. An account of it was given in the Agricultural Journal for October 1906, and a technical description of the parasite in the Memoirs, Volume I, No. 5, February 1907.

3. *Sugarcane diseases.*—The chief sugarcane diseases studied were red rot, smut, black rot and red leaf spot. Experiments with the former extending over two seasons show that the chief mode of conveyance is by the use of cuttings already containing the fungus. As this view is not in accord with the ideas prevailing in other countries where the disease has been a cause of loss, it required very full testing. The result has been to leave no doubt as to its substantial correctness in the more severe forms of the disease. Two distinct types of disease, however, occur and have been the cause of the misconception. In the milder first type air-borne spores gain access to the standing cane, being assisted by anything which tends to weaken the latter, such as the attacks of borers or leaf-hoppers. Individual canes become diseased, but the whole stool is not as a rule affected. The use of such infected canes as cuttings for seed leads to the second and (in Northern India) much the more severe type. The living fungus is planted out inside the cuttings and the resulting stool is attacked from below and eventually killed. The first form was active in the Pusa crop in the season of 1906-07, following on an epidemic of leaf-hopper. By carefully excluding all canes with recognisable symptoms of infection in selecting seed cane, the more serious type of disease can be, as a rule, eliminated. The practical conclusions to be drawn are that while it is impossible to avoid completely the first type of disease, it may probably be much diminished by checking pests and is not in any case likely to lead to very severe loss. Most of the loss caused by this disease is due to the use of infected seed and this loss can be avoided by discarding such seed in planting, without great difficulty. "Ratooning" varieties subject to the disease (as most of the thick canes) is liable to result in loss, which may be entire or almost entire if the ratooned crop had any large proportion of diseased canes the previous year. Further experiments are in progress to determine how far the fungus can exist in a cane without causing discoloration, whether soil infection ever occurs, the co-existence of other fungi in red rot, its connection with borers and some other points. Experiments with smut have been commenced this season. Black rot is primarily a disease of cuttings and is not at present a serious disease, though a near ally, the "pine apple" disease, is a cause of much loss in other countries. The latter was detected in newly imported cane and the consignment was destroyed. Accounts of these and other diseases of cane were published in the Memoirs, Volume I, No. 3, July 1906, and in a paper on the selection of sugarcane cuttings in the Agricultural Journal in April 1907.

4. *Cereal rusts.*—Experiments have been carried on in conjunction with Mr.J.M. Hayman, Deputy Director of Agriculture, United Provinces at Cawnpore in growing wheat in rust proof cases to test the validity of the "hereditary" theory of the disease. About 180 plants have been thus grown and two pustules of rust occurred in two cases this year. On the whole the evidence is against this being a frequent occurrence and it is possible that accidental contamination took place. A preliminary enquiry into the degree of resistance and susceptibility to rust was carried out at Lyallpur and Pusa, but it has been considered advisable to postpone taking this up in detail until pure races of Indian varieties have been separated. An account of the experiments and of the varieties, distribution, etc., of Indian rusts was published in conjunction with Mr. J. M. Hayman in the Memoirs, Volume I, No. 2, July 1906.

5. *Ground-nut leaf disease.*—Failure to establish this disease at Pusa has led to the abandonment of local experiments in its treatment. At Poona, steeping and spraying experiments are in progress, without as yet, any definite results.

6. *Wilt diseases.*—An area was reserved on the Poona Farm for an attempt to produce a resistant strain of pigeon pea by selection. Last year's results were promising. A similar experiment commenced at Pusa was destroyed by floods. Biological work with wilt-producing fungi absorbed much time but the conditions of infection are not yet determined. Wilts of cotton, gram, Bimlipatam-jute (Hibiscus cannabinus), sesamum and indigo have also been under study and it is probable that the majority of these diseases are caused by the United States cotton-wilt fungus (Neocosmospora vasinfecta) which was discovered to be widely distributed in India this year. A paper describing the pigeon pea wilt was published in the Journal in January 1906.

7. *Green-ear disease of cereals.*—Bajra, jowar, Italian millet and Euchlæna luxurians are all attacked in India by a parasite, Sclerospora graminicola, previously known on Italian millet and wild grasses only. An account of its life history and effects was published in the Memoirs, Volume II, No. 1, March 1907. This should enable practical methods of treatment to be employed in localities where it causes loss.

8. *Mango diseases.*—I visited Malda in August 1905, at the request of the Bengal Agricultural Department, to enquire into a disease which was reported to be damaging the valuable mango orchards of the district. The cause was found to be an alga already known as the cause of "red rust" of tea, one of the worst blights of this crop. The features of the disease correspond closely with those observed on tea and, like the latter, serious loss appears to be confined to certain districts, though the alga is widely distributed all over India. The conditions determining viru-

lence are not clearly known but they are evidently local, and prolonged investigation on the spot would be necessary before any suggestion for treatment could be made. This is not possible at present. Other minor diseases of the mango have also been studied.

9. *Other diseases.*—A large number of other diseases of plants, including most of the cultivated crops of the plains and several fruit and economic plants, were examined. A proportion of these are specimens sent in by Superintendents of Farms and other persons interested in agriculture, and reports are issued giving such recommendations for prevention or remedy as are likely to prove most useful. Others are collected by the establishment. Information regarding these is steadily accumulated, cultures obtained, the life histories studied and inoculations tried as opportunity permits. When necessary, a personal visit is made to the locality reporting the disease, or an assistant is deputed for local investigation. It will be years before we have anything like a comprehensive knowledge of Indian plant parasites and every occasion is utilised towards this end. This may be taken as the routine work of the Laboratory at present. It is essential to acquire information regarding the characters, distribution and effects of the diseases of important crops in India as rapidly as possible. A few only can be selected for further investigation at any one time. Such are, at present, the cereal rusts, sugarcane diseases, wilts of Leguminosæ, and Malvaceæ, and palm diseases. In some cases simple preventive or remedial measures suggest themselves at once, and detailed study can be left over. A commencement has been made in expanding work through the medium of trained native assistants in the Provincial Departments. These men will be able to inculcate simple measures of improved sanitation, the selection of disease-free seed, the destruction of infective matter and the like; they will also assist largely in the crop disease survey. Larger measures of dealing with severe outbreaks of disease must be, as far as can be judged at present, left to Government agency. Government can also take an active part in checking imports of disease and in providing disease-free seed through seed farms. Further progress in the general control of plant diseases depends on the education of the cultivators.

10. *Soil inoculation for legumes.*—Field experiments with cultures of the bacilli obtained from pigeon pea, grown and applied after the methods recommended by the United States Department of Agriculture were carried out at Dehra Dun and Pusa. The Dehra Dun experiments, which alone were satisfactory, showed that no appreciable gain resulted from the application. The probable explanation is that bacilli, capable of forming nodules on this commonly grown pulse, must have been present in the field even though the crop itself had not recently been grown there.

11. *Fungus diseases of injurious insects.*—A joint investigation of the possibilities of this method of destroying locusts was carried out with the Imperial Entomologist. The locust fungus is a parasite which is capable of causing epidemic disease in certain locusts. Healthy specimens of the Bombay and North-West Migratory locusts and some species of grasshoppers were inoculated with pure cultures of the fungus, in various ways. Everything was done to increase the chances of infection. The results showed that for the species tested, the method is not likely to be of the slightest use. A Bulletin (No. 5 of 1907) giving details of the experiments and results is now printed. A supposed parasite of the green coffee bug was imported by the United Planters' Association of Southern India and forwarded to Pusa for cultivation. Repeated attempts were made to obtain a strong growth, but it failed to thrive and reports from South India indicate that no cases of infection occurred even with the freshly imported material, so that nothing is to be expected from this method of fighting the pest. These results are in harmony with the general experience of other countries, where the claims of those who advocate this line of work have not as a rule borne full enquiry.

12. *Soil fungi.*—A commencement has been made in the study of the soil fungi which assist in the decomposition of organic matter and help to render it available for plant food. The necessary preliminary to this is a knowledge of the species which are most constantly present in a given soil. This work has been in the hands of Mr. S. K. Basu, M.A., 1st Assistant, who has isolated and determined a number of the commoner soil forms at Pusa.

13. *Systematic Mycology.*—A monograph of the genus Pythium, an imperfectly known group of lower fungi to which the "damping off" and palm rot parasites belong, was published in the Memoirs, Volume I, No. 5, February 1907. To this was added a description of its parasites and some allied fungi. The first part of a systematic account of the fungi in the Herbarium at Pusa, entitled "Fungi Indiæ Orientalis", was published in conjunction with Messrs. H. and P. Sydow in the Annales Mycologici for October 1906. A second part is in preparation. Part of the collections of fungi, chiefly the larger woody forms, was sent to Kew, and descriptions of the new species published by Mr. G. Massee in the Kew Bulletin.

14. *Text-book.*—Some progress has been made in the preparation of a text-book of Indian diseases of plants. It is hoped to complete this during the coming year. Nothing of the sort is available for students of tropical and sub-tropical plant diseases.

15. *Training.*—The training of probationary assistants for the Central Provinces and Bengal was completed in April 1907. A pro-

bationer for the United Provinces has been under training since the 4th March 1907.

16. *Establishment.*—The staff has been strengthened by the recent appointment in England of Mr. W. McRae, M.A., B.Sc., as Supernumerary Mycologist. This officer has not yet, however, joined in India. Mr. J. H. Mitter, B.Sc., was appointed 2nd Assistant in July 1906. Babu R. R. Sen was appointed 3rd fieldman in August 1905, and N. C. S. Gupta, 4th fieldman, in December 1905, but transferred on deputation to the office of the Director, Pusa, in June 1906. All have worked satisfactorily, particularly Mr. S. K. Basu, Senior Assistant, Munshi Inayat Khan, 1st fieldman, and Babu Rameshwar Dayal, Clerk.

E. J. BUTLER,
Imperial Mycologist.

PUSA.
The 18th August 1907.

PART V.

REPORT OF THE IMPERIAL ENTOMOLOGIST.

1. *Training.*—Entomological Assistants were given a full course of training for the Agricultural Departments of Bombay, Bengal, United Provinces, Madras and Assam. A short course of training was given to the Entomological Lecturer, Poona Agricultural College, to a Farm Overseer undergoing a general Agricultural training for Bengal, and to six Agricultural Assistants who had completed their agricultural course at the Cawnpore Agricultural College for the Punjab Agricultural Department.

2. *Establishment.*—The Supernumerary Entomologist, Mr. C. W. Mason, arrived in December 1906. In anticipation of the appointment of the Second Entomologist, the staff allotted to this officer was appointed. The post of First Assistant to the Imperial Entomologist was held by C. S. Misra who is directly engaged in training the probationers sent to Pusa. The second Assistant, C. C. Ghosh, has had charge of the insectary. One Assistant, T. V. R. Aiyar, was transferred to Madras as Entomological Assistant. P. G. Patel has been specially employed to work at biting flies. The other assistants are now being trained. The artist staff appointed for the Institute and for the Journal worked under my guidance.

3. *Buildings.*—The insectary was occupied in July 1905; the insecticide godown has been used as a laboratory since June 1906 and a large part of the staff still work in the old barn. Lack of light and of working accommodation have caused great difficulties in carrying out Laboratory work. The full work of my section can only be entered into when the permanent Laboratory is complete.

4. *Provincial work.*—Trained Assistants are now employed in each Province and, in most cases, the Imperial Entomologist suggests and guides the year's programme of work. Progress has been made in the general study of injurious insects. In the Punjab, the severe outbreak of boll-worm required special measures which are reported to have given good results. The three principal measures were:—

(1) Removal and burning of the old plants in January.

(2) The cultivation of *bhinda* (Hibiscus esculentus) as a trap crop.

(3) The reintroduction of the parasite of the boll-worm.

The first did good generally, but the second was a general failure except in such localities as depended on well irrigation and where

the people understood how to grow the plant. The third measure was an apparent success. Damage estimated in 1905 at two to three crores of rupees was very greatly reduced in 1906 by these measures and in 1907 the crop is reported to be normal, the parasite being abundant generally. In Sind, the loss in 1906 was as bad as in 1907, but the parasite was reintroduced in April-May 1907 from Pusa and is now re-established there. The Bombay Entomological Assistant has given special attention to the outbreak of Potato Moth, an imported pest. In the Central Provinces, good progress has been made in investigating the general pests and a good course of practical entomology is being framed for the college. In Madras and Bengal good progress has also been made in general investigation regarding injurious insects.

The Provincial Entomological Assistants meet at Pusa in January of each year to discuss the year's programme, see the progress made at Pusa and compare notes. Real progress regarding Entomological enquiries is being made in the various Provinces and useful information about the injurious crop pests can without difficulty be diffused.

5. *Correspondence.*—Reports of injury to crops with specimens of the insects are received from the District officials and when possible a report is sent back at once. These district reports show when insects are doing injury and would be extremely valuable if more frequently sent; damage by insects is constantly reported in the weekly crop reports, but no report with specimens is sent to Pusa. I receive numerous enquiries from Farm Superintendents, Superintendents of the State Gardens, and from other official sources; from commercial firms, planters, zemindars and other private individuals. These enquiries cover a wide range and I have to devote much attention to answering them. A considerable part of my work is devoted to acquire the information necessary to answer such enquiries.

6. *Research.*—Progress has been steadily made in the investigation of the life histories and habits of injurious insects. A detailed study has been made or is being made of the most important insects, but for numerous destructive insects a full enquiry must wait until we have more time. For each injurious insect all observations are recorded and will in time be worked up. Every stage of the insect's life is recorded pictorially by an artist and the "plate" to illustrate each insect is brought to completion. When particular insects begin to do damage to crops, methods of treatment are experimented with. In co-operation with Mr. R. S. Finlow, a special investigation into insecticides was made, in the hope of finding a substance poisonous to insects but not poisonous to cattle, which could be applied profitably in the field. This investigation has reached the stage of field trials. Other subjects under enquiry, as time allows, are the

nfluence of climatic phenomena on insects, the utilisation of beneficial insects and the value of trap crops in Indian Agriculture. In collaboration with the Imperial Mycologist an enquiry was made into locust fungus and its value.

The cultivation of "Eri" silk was taken up to determine whether the worms will survive the dry hot weather or can be acclimatised to it. Lac was also introduced under cultfvation, as there is a large field for lac culture on existing trees in Behar.

7. *Insect survey.*—In addition to work of a purely economic nature, provision has to be made for teaching, both in the shape of a collection of the common insects of India and of facts concerning them. The general collection of insects at Pusa has accordingly been made as large as possible. The insects collected are, when necessary, sent to specialists in Europe or America for identification and are then classified. Large collections have been sent to England for the use of authors of prospective volumes of the Fauna of India; I have received the greatest help from the Editor of the Fauna, Colonel Bingham, and our collection owes much to the generous help of Mr. H. E. Andrewes, in sending named specimens of beetles.

It has also been necessary to gather together all the recorded information about insects as the basis of teaching and to supplement this by observation and research. This has been done and the text of a volume on the insects of the cultivated areas of India has been prepared. This will serve as a basis for teaching or, if published, will be an advanced student's text-book and a manual for all workers in Entomology in India. No such work exists at present and its preparation has taken much time. Mr. F. M. Howlett, who will take up the work of the Second Imperial Entomologist in November has collaborated. He has been working at Indian Diptera in England.

8. *Summary.*—The chief work of the past two years has been a continuation of the preliminary work commenced in 1903, the chief object being the study of the injurious insects of this country with a view to recommend measures to check them or at least to give reliable information about them. The publication of this information is important to the agricultural classes. Practical instruction in entomology can be more effectively carried out when the Provincial Agricultural Colleges and the permanent Laboratories at Pusa are opened.

9. *Publications.*—"Indian Insect Pests" is the most important item and its publication and wide circulation in India has already produced marked effects. The publication of the Journal and Memoirs has given me heavy work. I have had to supervise the preparation of illustrations for all sections of the Institute including the reproduction of the plates and illustrations of the Journal and Memoirs. I have acquired technical knowledge of printing processes, under some

difficulties. The publishers have introduced the "Three Colour Process," and other improvements and illustration work in India is being vastly improved. Although the work of Messrs. Thacker, Spink & Co. is excellent, we have great need for an Assistant Editor skilled in printing processes and who can bring the work of illustrating to the highest possible level without increased cost. I consider that an Assistant Editor for our publications is urgently required.

H. MAXWELL-LEFROY,
Imperial Entomologist.

PUSA;
The 12th August 1907.

PART VI.

SUMMARY OF THE REPORT OF THE IMPERIAL AGRICULTURIST.

1. *Staff.*—Mr. E. Shearer was in charge of the section for the whole period. Mr. R. W. B. C. Wood joined as supernumerary in October 1905. In May 1906, he was appointed Deputy Director of Agriculture in Madras. Mr. A. G. Birt and Mr. W. Roberts joined each as a supernumerary in October 1906, and Mr. G. Garrad, in December 1906. Mr. Garrad was deputed to Bombay in May 1907 and Mr. Roberts to the Imperial Agricultural Chemist, each for special agricultural work which will probably give them some experience necessary for Provincial appointments.

2. *Historical.*—The Pusa estate of over 1,300 acres was largely occupied by jungle when first taken in charge by the Agricultural Department and the work of clearing the good land for arable cultivation has been extensive and costly. The work is not complete and apart from agriculture the amenities of the estate in this section still require considerable improvement.

3. *Training.*—Two probationers from Bengal completed two years' training in April 1906, and were respectively appointed overseers on the Bankipur and Sabour Farms. A probationer from the Central Provinces completed eighteen months' training in March 1907, and was appointed overseer on the Akola Farm. A probationer from Bengal was, after six months' training, appointed in December 1906, Travelling Inspector of Agriculture in the Orissa Division of Bengal. Another from Eastern Bengal and Assam continues under training.

4. *Cropping.*—The crops on particular selected fields were grown with the intention to determine how far the fields are uniform in character so that they may be eventually devoted to permanent experiments. The produce from each acre of these fields has been weighed separately. Information regarding the suitability of particular areas for particular experiments is required and a decision on this point will be come to shortly. So far, the indications are that, while large areas are not uniform, considerable blocks will be suitable for accurate experimental work.

5. *Cotton.*—Extensive trials began in 1904 and included the following :—

(*a*) Selected indigenous (annual and tree varieties).
(*b*) Newly imported American.
(*c*) Acclimatised American.
(*d*) Egyptian.

The general results have been unsatisfactory. It has been therefore decided that other crops are more profitable in Behar. In consultation with the Inspector-General of Agriculture, it has been further decided that these experiments should be abandoned. The varieties of tree cotton have given particularly unsatisfactory results at Pusa.

6. *Sugarcane.*—Twenty-five varieties were tested as regards methods of cultivation, manuring, irrigation, susceptibility to disease, outturn, etc. Damage was done particularly to thick soft varieties by white ants, borers, leaf hoppers, jackals and pigs. Fungus diseases caused considerable damage. Dr. Butler deals with the last-named troubles and Mr. Lefroy with insect attacks.

7. *Jute.*—Forty-four varieties of jute were grown in 1906, forty-two of *C. capsularis* and two of *C. olitorius.* The results are described in a general way by the Fibre Expert.

8. *Flax.*—Experiments with this crop have been carried on since 1904 for seed and fibre but chiefly for the production of fibre. The various varieties imported from Russia, Belgium and Ireland grew very well. An estimate of their value for fibre does not belong to my Department.

9. *Mangel wurzels.*—Mangel wurzels, as well as turnips, are grown to a limited extent in Northern India. The former was grown at Pusa in the rabi season of 1906 on well manured irrigated land and yielded just under 20 tons per acre. This crop will probably supply in part very suitable food for our cattle and sheep in the hot weather.

10. *Green manuring.*—The advantage of green manuring with San-hemp was tested and, in newly broken land, proved very profitable.

11. *Trial of new pasture grasses.*—The seeds of *Chloris virgata* (known in South Africa as "Rhodes grass") and *Chloris gayana* were received from New South Wales. They grew well and will be tried again on a larger scale.

12. *Breeding herds.*—Montgomery cattle continued to do well. The best of them give eight to nine sers* of milk a day when in full profit but this yield is less than in their own country. These cattle have remained healthy.

A herd of local cattle was started with the object of distributing bulls to improve Bengal cattle and the management is practically supervised by the Bengal Civil Veterinary Department. This breed is kept at Pusa to supply Provincial requirements but under present circumstances could possibly be more correctly controlled on a farm managed by officers of the Bengal Government.

13. *Establishment.*—The staff have worked well especially the two Farm Overseers, Mr. Gulabbhai Desai and Mr. Mohammed Ikram-uddin, and Mr. Judah Hyam, the Veterinary Overseer, who is in charge of the breeding herds.

* Ser = 2 lbs.

PART VII.

SUMMARY OF THE REPORT OF THE IMPERIAL ECONOMIC BOTANIST.

1. Mr. A. Howard took up appointment in India in May 1905. During the first three months he saw a good deal of the work carried on by the Agricultural Departments in various Provinces. The area under his charge at Pusa contains a fruit orchard and also a Botanical Garden which is in part devoted to such crops as he is studying. The area is securely fenced and laid out conveniently with paths and in plots. The Botanical Garden of Economic plants is only now being laid out as funds were not available until this year. The want of a laboratory and apparatus greatly impeded his work at Pusa during the first year. Convenient buildings have since been erected. One building is provided with north light and is quite suitable for laboratory work.

Extensive orchards have been planted and these comprise plots of peaches, figs, mangoes, litchis, guavas, loquats, plums and citrus fruits. The experimental scheme refers to pruning, cultivation, irrigation, manuring, planting and the influence of stocks on the scion. The whole is commanded by irrigation from the river and drainage has been arranged for. An account of this work has been published as Bulletin No. 4 of the Agricultural Research Institute, Pusa. The fruit trees are yet all young. They have, however, grown well and all are likely to succeed as they were selected as suitable for the soil and climate of Pusa. Some trees have already fruited. The fruit from the peach trees was notably perfect.

2. *Wheat investigation.*—In 1905, Mr. Howard collected many samples of seed in the wheat-growing districts. These samples mostly contained mixed seed. The different varieties had to be sorted out and their botanical characters and agricultural values studied. He has obtained a representative collection of Indian wheats through the Agricultural Departments, the Reporter on Economic Products, the Superintendent, Botanical Survey of India, and from other sources. He has undertaken a detailed study of the Punjab wheats at the request of the Punjab Director of Agriculture. A preliminary classification was made in 1906. By extensive field studies a classification of all wheats grown in the various Provinces has been nearly finished. He started cross-breeding wheat experiments in the Punjab and at Pusa. On account of favourable climatic conditions the former are

likely to be the most productive. The cross-breeding wheat experiments in the United Provinces and in Bombay have been conducted by local officers for a number of years. Mr. Howard is preparing a book of reference regarding Indian wheats. The work has been more laborious than he expected. He hopes to finish it soon.

3. *Tobacco.*—The study of the numerous varieties grown in India has been commenced. Exotic varieties likely to grow well in India have been collected. A classification of various types is a necessary preliminary to work on improvement. This classification has been undertaken.

4. *Barleys.*—A survey of the barleys grown in India is being made with the aim of improving this crop by cross-breeding and selection of seed. Many varieties were grown at Pusa in 1906-07.

5. *Ganja* (*Cannabis sativa*).—The attention of the Imperial Economic Botanist has been drawn to the need of a biological study of the *ganja* plant, but at present he is fully employed on other and more important work and a general enquiry must wait. He has, however, started minor enquiries regarding this crop at Pusa.

6. *Library Catalogue.*—A complete revision of the Library catalogue was found necessary and was undertaken in 1907.

7. *Tours.*—Mr. Howard toured extensively to become acquainted with the agricultural conditions of various parts of India, to see the general agricultural and experimental work which is being carried out in the Provinces, and to gain special information regarding his work on wheat.

8. *Staff.*—Mr. R. J. D. Graham, M.A., B.Sc., has been appointed Supernumerary Economic Botanist, and arrived in May 1907. Mr. Howard has found difficulty in obtaining a sufficient staff, because neither pay nor prospects are at present attractive.

APPENDIX A.

A SHORT ACCOUNT OF RECENT WORK IN BEHAR IN INDIGO RESEARCH.

In continuation of the far more extensive work of the previous years experiments in manufacture have been carried out at Pusa and at the Bengal Research Station (Sirsaah), but chiefly at the latter place.

The Java and Sumatrana varieties yielded the largest outturns of dye by steeping in water at a temperature of 104° F. for 7 hours. These results require confirmation. Extra expense is incurred by using water at a high temperature but water which is too low in temperature is frequently employed with loss on cold and wet days at the beginning and at the end of the manufacturing season. The value of the plant at various stages of growth has been investigated and the study of the fermentation process has been further extended. It is recommended that the conditions of time and temperature mentioned above should be rigidly adhered to. There are inevitable losses of indigotin in the seet water and also in boiling, straining and pressing; but it is believed that an increase of outturn can be usually obtained between the oxidizing process and the finished product. This is under investigation. Attention has been directed to drying indigo in the form of powder as indigo cakes have to be reduced to powder for dyeing purposes. The agricultural and laboratory tests have clearly proved the superiority of the Java plant over the old Sumatrana variety. The difficulties connected with the poor germination of Java seed have been overcome. Treatment with sulphuric acid is effective. The idea was suggested by Dr. Butler and the treatment is successful because the outer tough coat of the seed is weakened and germination in the ordinary moisture of Indian soils is thereby facilitated. The Java plant is a perennial. It should be sown in October-November and cut back in the spring in order to multiply branches and increase leaf growth. There are divided opinions regarding the effect of pruning in subsequent years and the question requires further investigation. As regards manurial experiments no very definite results can yet be reported. The inoculation of Indian soils with a culture of the appropriate nodule bacteria has produced no advantageous results in Behar, presumably because the soils of this district are already sufficiently stocked with such bacteria. Considerable advance has been made in supplying good seed of both Java and Sumatrana varieties to Indigo Planters from established seed farms.

The Behar Indigo Planters' Association have appointed a Botanist and further advancement in indigo research in India will greatly depend upon his work. Nothing has yet been done to separate the best types of plants of any particular variety. The indigo industry is by no means yet dead in India and may yet become again very prosperous by seed selection on rational lines and by other agricultural improvements which are quite feasible. Much less attention has been given to the agricultural improvement of the crop than to chemical and other enquiries regarding the best means of extracting the dye.

Samples of known indigotin content sent to various analysts for examination showed considerable discrepancy in their results. A uniform method of trade analysis for indicating the true indigotin content of the samples dealt with has, therefore, been attained and its use by the leading analysts of Calcutta and England secured. The relative dyeing values of synthetic and natural indigo have been tested by Mr. Bergtheil and very interesting results were obtained. Further trials are probably necessary, but as far as the tests at Cawnpore go natural indigo gave a better depth of colour than synthetic indigo and was pronounced a better dye for ordinary Indian cloths. Mr. Bergtheil is, at present, on leave in England. When he returns from leave his research work regarding indigo will be continued at Pusa where complete arrangements have been made for manufacture and research. We may thus help European Planters in Behar, but we are still more likely to help the backward methods of manufacture in the United Provinces and Madras where cultivation has recently extended.

APPENDIX B.

A SHORT ACCOUNT OF EXPERIMENTS WITH JUTE AND OTHER FIBRES.

JUTE.

For several years the jute trade has been in a critical condition but it has been generally profitable to Indian cultivators and dealers. There has been a large expansion in its cultivation. The demand for the fibre increased so rapidly that supplies began to run short during 1905, with the result that prices had doubled. In 1906 and 1907 the areas under this crop expanded considerably with the result that in 1907 prices have fallen steadily and in time will probably become more normal.

Jute Extension.—Mr. Finlow, the Fibre Expert, has published a full report (Agricultural Research Institute Bulletin No. 3 of 1906) which deals with the possibilities of extending jute cultivation in various Provinces. This report has been supplemented by the report of Mr. F. Smith, published in the Agricultural Journal of India, Vol. II, Part 2, April 1907, which refers particularly to the results of the experiment in Bengal. Outside Bengal, Madras appears to offer more favourable opportunities for jute cultivation than any other part of India. The climate of the Malabar Coast is distinctly similar to that of Bengal, although the hilly nature of some parts indicates unsuitability at first sight. Trials with jute have been conducted in the Godavari delta, at the Samalkota Experimental Station, since 1905, by Mr. Barber, the Madras Government Botanist. The results of the experiments in 1905 were not successful, but in 1906, owing to better experience regarding the necessary agricultural conditions, they were much more satisfactory. These experiments have been continued at the Samalkota Farm in 1907 and seed has been distributed to a number of cultivators in the district, who have received advice from the Agricultural Department regarding the proper method of cultivation. In 1907, jute experiments are also being carried out in other parts of Madras, notably at Tanjore in the Godavari delta on the Malabar Coast. In Bombay, trials were carried out in 1906 at the Ganeshkhind Gardens, Poona, by Professor Gammie on manured land but without irrigation. A yield of over 7½ maunds of fibre per acre was obtained, the value in Calcutta being Rs. 10-4-0 per maund. A larger area has been put down this year. Experiments at the Poona and Manjri Farms—at the latter with irrigation—are also being continued. Conditions in the rice districts of Bombay are not so favourable as in Madras owing to the want of early rains. The Central Provinces commenced trials with jute in 1905 at Nagpur and at Raipur, which were continued in 1906; the results were not satisfactory, chiefly because there are usually no premonsoon showers and the seed cannot, therefore, be sown early enough under favourable circumstances. This season (1907), however, sowings were made at Raipur on manured land in April with well irrigation and the results are reported to be much more promising. Well irrigation early in the season is very expensive and it is extremely doubtful whether it will pay even with a valuable crop like jute in the Chhattisgarh district where rice is practically the only crop at present. Behar and the Assam Valley, where jute had not hitherto been cultivated to any large extent, will probably produce very fine crops as experience is gained by cultivators. In 1904, Behar Indigo Planters began to get interested in jute and their tenants are now growing the crop to a considerable extent. In this tract, about 8,500 acres are under cultivation in the Mozafferpore and Champaran Districts this season (1907). Jute cultivation will probably extend largely into the plains of Assam because physical and climatic conditions are suitable. During the months of March, April and May of the present year, Mr. Finlow made a prolonged tour through the districts north and south of the Brahmaputra, including Cachar. The land near the river on both banks of Brahmaputra is in some places subject to deep inundation in the rainy season, but in others the banks are

practically, if not entirely, above flood level. Away from the river, there are large areas of rich land, much of it virgin and covered with dense reed jungle which, when brought under cultivation, may yield large crops of jute. The cultivation of jute is extending rapidly in the western end of Assam Valley where the acreage is estimated at 60,000 acres this year (1907) as against 33,700 acres in 1906. Many tea planters are interested, but the lack of labour will prevent rapid development. Forty-four varieties of jute were grown at Pusa in 1906, with two objects —(*a*) to commence plant to plant selection of seed, (*b*) to study the botanical characteristics of the different races and their agricultural values. Our observations tend to show that the Bengal jutes can be generally classified into (*a*) green stemmed races, (*b*) red stemmed races, (*c*) early maturing races, and (*d*) late maturing races. Different districts do produce fibre of different qualities and we are enquiring into the reasons. A full report on the experiments made at the Burdwan and Cuttack Farms has been published by Mr. F. Smith in Agricultural Journal, Vol. II, Part 2, April 1907.

Seed Distribution.—The Bengal Agricultural Department in 1906 distributed about 300 maunds of seed of jute from crops grown specially for the purpose. The Eastern Bengal Department of Agriculture also distributed 75 maunds of seed grown at the Rajshahi Farm, a considerable proportion of the latter was distributed in small quantities free of charge to intending cultivators chiefly in Assam. Part of the seed was also used for experimental purposes in other parts of India.

Jute substitutes.—The question of utilizing the various fibre plants which are possible substitutes for jute is assuming increasing importance. Both San-hemp (*Crotalaria juncea*) and *Hibiscus cannabinus* are grown throughout India chiefly for home use but to a considerable extent for export. Madras had nearly 70,000 acres of *Hibiscus cannabinus* in 1906 (the acreage for 1905 was probably less than 45,000) grown for export, or for gunny bags made in the mills at Bimlipatam. Seventy thousand acres of San-hemp were grown in the plateau districts of the Central Provinces in 1905. The crop is also fairly important in Madras, the Punjab, Bombay and Bengal.

While these and other fibres have not all the peculiar properties of jute, they are superior to it in some respects and can be used for purposes for which jute is not suitable.

Other jute investigations.—Mr. Finlow has made arrangements with Messrs. Cross and Bevan of London, the well-known authorities on cellulose, to collaborate with them in certain scientific investigations regarding fibres. The first of these investigations is an attempt to find out the cause of the alleged deterioration which has occurred in jute during recent years. It is hoped that the Calcutta Baled Jute Association will co-operate in the enquiry which will, in the first instance, be chiefly bacteriological.

Diseases.—During the present season the crops of jute over a large part of Bengal have been attacked by insects ; but serious damage has not been done except in a few instances. The Imperial Entomologist is dealing with these pests.

Fraudulent watering of jute is a common practice among small dealers and leads to much damage to baled jute during transport to Europe. Repressive legislation which was regarded as essential by a considerable section of the commercial community was declined by the Governments of Bengal and Eastern Bengal and Assam on various grounds.

Scientific work.—A temporary laboratory has been equipped at Pusa and work has been carried on during the last three months. At present the investigations are devoted chiefly to a chemical and microscopical examination of numbers of samples of fibre with the object of establishing data to assist the selection experiments in the field. Other problems will be taken up as opportunity offers.

Flax.

Experiments in cultivating flax in India as a fibre crop began as early as 1840 but no definite results were obtained. Experiments have again recently been started chiefly by Sir Lewis Hay, Bart., who, together with his manager Mr. Cameron, has

commenced operations on a large scale at Dooriah, Behar. The results of these experiments were considered by the Government of Bengal to justify assistance and an expert flax cultivator, M. Vandekerkhove, from Belgium, was appointed in February 1907. He will have to gain experience of Indian conditions of cultivation before he can give reliable advice on all points regarding the prospects of the crop. He states, however, that the weight of the rippled straw at present obtained in India is only about half of the yield obtained in Europe. He considers that this return would not be sufficiently remunerative to induce cultivators to take up flax ; but he is quite sanguine that better results can be obtained by increasing the yield of straw per acre and by more expert manipulation in the extraction of the fibre. The retting process should be carried out in the fair season not in the rains. The hot weather is too dry for the breaking and scutching processes. Six varieties of imported flax were grown at Pusa during the rabi season of 1906-07; both for fibre and for seed. The yields of straw rippled (threshed), unrippled and seed were fairly satisfactory. Unfortunately, part of the machinery obtained from Europe for extracting the fibre arrived in broken condition so that it is impossible to give yields of fibre at present. The best plots gave about 25 maunds of rippled straw per acre. The European yield is from 40 to 50 maunds per acre. The cultivation expenses in Europe are higher than in India and acclimatization of seed may tend to increase the yield in India. The experiments will be continued until definite issues are obtained and a note will be published regarding results as soon as full experience on the prospects of the crop has been gained. In considering the value of a flax crop account must be taken of the seed, as the straw need not be cut for fibre until the seed is approaching ripeness. The average yield of seed from each of four plots at Pusa was worth about Rs. 17 per acre.

Mr. Finlow hopes in time to show, as regards Bengal and Eastern Bengal and Assam, (*a*) the best varieties of fibre plants to grow, (*b*) the best methods of cultivation, (*c*) the best means to produce the best fibre for the market, (*d*) the best means of getting full value for good fibre, and (*e*) the best way of growing seed on a large scale for distribution. He also hopes to be able to show to which areas jute cultivation can be profitably extended, where jute substitutes can be profitably grown and in which parts other profitable fibre plants can be introduced.

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APPENDIX C

List of Agricultural Publications in India during 1905-06 *and* 1906-07.

No.	Title.	Author.	Where published.
		General Agriculture.	
1	Annual Report of the Imperial Department of Agriculture for the year 1904-1905. Price 12 annas.	Inspector-General of Agriculture in India, Nagpur, Central Provinces.	Government Printing, India, Calcutta.
2	Proceedings of the Board of Agriculture in India, 1906. Price 12 annas.	Ditto ditto .	Ditto.
3	Proceedings of the Board of Agriculture in India, 1907. Price Re. 1-2.	Ditto ditto .	Ditto.
4	Annual Report of the Board of Scientific Advice for the year 1904-05. Price Re. 1.	Secretary, Board of Scientific Advice, Calcutta .	Government Central Press, Calcutta.
5	Annual Report of the Board of Scientific Advice for the year 1905-06. Price Re. 1-2.	Ditto ditto .	Ditto.
6	Agricultural Statistics of British India, 1904-05. Price Rs. 3.	Director General of Statistics . . .	Government Printing, India, Calcutta.
7	Agricultural Statistics of Native States, 1904-05. Price Rs. 3.		
8	Area and yield of certain crops in India, 1905-06. Price 5 annas.	Department of Commerce and Industry . .	Ditto.
9	Agricultural Journal of India, Vol. I, Parts 1-4. Price Rs. 6.	Agricultural Research Institute, Pusa . .	Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
10	Agricultural Journal of India, Vol. II, Parts I to IV. Price Rs. 6.	Agricultural Research Institute, Pusa	Messrs. Thacker, Spink & Co., Calcutta.
11	The Extension of Jute Cultivation in India. Bulletin No. 3, 1906, of the Agricultural Research Institute, Pusa. Price 12 annas.	R. S. Finlow, B.Sc., F.C.S., Fibre Expert to the Government of Eastern Bengal and Assam.	Government Printing, India, Calcutta.
12	Note on the Oudh Seed Depôts	W. H. Moreland, C.I.E., I.C.S., Director of Agriculture, United Provinces of Agra and Oudh.	Ditto.
13	Report on the Control and Utilization of Rivers and Drainage for the fertilization of Land and mitigation of Malaria.	Sir Edward Buck, K.C.S.I., LL.D.	Government of India, Revenue and Agricultural Department.
14	Sorghum Vulgare, Pers. (Andropogon Sorghum, Brot). The great millet or Juar in India. Agriculture Ledger No. 6 of 1905. Price 6 annas.	Sir George Watt, Kt., C.I.E.	Government Printing, India, Calcutta.
15	Phœnix Dactylifera Linn. (The Date Palm). Part I. Notes on Date Palm cultivation in countries other than India. Agriculture Ledger No. 1 of 1906. Price 3 annas.	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture, Bombay Presidency.	Ditto.
16	Psophocarpus Tetragonolobus (Goa Bean) Goa Beans in India. Agriculture Ledger No. 4 of 1906. Price 3 annas.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India.	Ditto.

17	Report of the Agricultural Department, Bengal, for the period of 15 months from 1st April 1905 to 30th June 1906. Price 8 annas.	Department of Agriculture	The Bengal Secretariat Book Depôt, Calcutta.
18	Report on the Administration of the Department of Agriculture of the United Provinces of Agra and Oudh for the year ending 30th June 1906. Price 8 annas.	Ditto	United Provinces Government Press, Allahabad.
19	Report on the operations of the Department of Land Records and Agriculture, Punjab, for the year ending 30th September 1905. Price 5 annas.	Ditto	Civil and Military Gazette Press, Lahore.
20	Report on the operations of the Department of Agriculture, Punjab, for the year ending 30th June 1906. Price 4 annas.	Ditto	Ditto.
21	Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1905-06.	Ditto	Government Central Press, Bombay.
22	Report on the working of the Department of Agriculture of the Central Provinces, during the year ending 31st March 1906. Price Re. 1.	Ditto	Secretariat Press, Nagpur.
23	Report on the operations of the Department of Agriculture, Madras Presidency, for the official year 1905-06. Price 6 annas.	Ditto	Government Press, Madras.
24	Burma Land Records Administration Report for the year ending 30th June 1906. Price Re. 1.	Ditto	Government Printing, Burma, Rangoon.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
25	Report of the Agricultural Branch of the Department of Land Records and Agriculture, Eastern Bengal and Assam, for the year 1905-06.	Department of Agriculture	Eastern Bengal and Assam Secretariat Press, Shillong.
26	Annual Report of the Burdwan Experiment Station for the year 1905-06. Price 4 annas.	Ditto	The Bengal Secretariat Book Depôt, Calcutta.
27	Annual Report of the Dumraon Experiment Station for the year 1905-06. Price 2 annas.	Ditto	Ditto ditto.
28	Annual Report of the Sripur Experiment Station for the year 1905-06. Price 2 annas.	Ditto	Ditto ditto.
29	Annual Report of the Cuttack Experiment Station for the year 1905-06. Price 2 annas.	Ditto	Ditto ditto.
30	Report on the Cawnpore Agricultural Station in the United Provinces for the year ending 30th June 1906. Price Re. 1.	Ditto	United Provinces Government Press, Allahabad.
31	Report on the Agricultural Station, Orai, Jalaun, of the United Provinces of Agra and Oudh, for the year ending 30th June 1906. Price 8 annas.	Ditto	Ditto ditto.
32	Annual Report of the Government Experiment Farm, Lyallpur (Punjab), for the Kharif and Rabi Seasons, 1904-05. Price 5 annas.	Ditto	Civil and Military Gazette Press, Lahore.

33	Annual Report of the Government Experiment Farm, Lyallpur (Punjab), for the Kharif and Rabi Seasons, 1905-06.	Ditto	Ditto	Ditto.
34	Annual Report of the Agricultural and Botanical Stations in the Bombay Presidency for the year 1905-06. Price Re. 1-2.	Ditto	Government Central Press, Bombay.	
35	Report on the Agricultural Stations in the Central Provinces for the year ending 30th June 1906.	Ditto	Secretariat Press, Nagpur.	
36	Annual Report on the Agricultural Stations in Eastern Bengal and Assam for the year ending 30th June 1906.	Ditto	Eastern Bengal and Assam Secretariat Press, Shillong.	
37	Annual Report of the Tropical Plantation at Wahjain for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
38	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
39	Annual Report of the Rangpur Agricultural Station for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto.
40	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto
41	Annual Report of the Shillong Fruit Gardens for the year ending 30th June 1906. Price 2 annas.	Ditto	Ditto	ditto,
42	Scientific Report of the Attur Agricultural Station for the official year 1905-06.	Ditto	Government Press, Madras.	

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
43	Scientific Report of the Hagari Agricultural Station for the official year 1905-06.	Department of Agriculture	Government Press, Madras.
44	Scientific Report of the Bellary Agricultural Station for the official year 1905-06.	Ditto	Ditto.
45	Scientific Report of the Palur Agricultural Station for the official year 1905-06.	Ditto	Ditto.
46	Scientific Report of the Koilpatti Agricultural Station for the official year 1905-06.	Ditto	Ditto.
47	Report of the Indigo Research Station, Sirsiah, for the year 1905-06.	C. J. Bergtheil, Imperial Bacteriologist . .	Behar Planters' Association, Mozufferpore.
48	Report of the Indigo Research Station, Sirsiah, for the year 1906-07.	Ditto ditto . .	Ditto.
49	Ficus Elastica. Its natural growth and Artificial propagation. Forest Bulletin No. 4.	E. M. Coventry, Deputy Conservator of Forests .	Government Printing, India, Calcutta.
50	The cultivation of Ficus Elastica. Price Re. 1-6-0.	Claud Bald	Messrs. Thacker, Spink & Co.
51	The Objects and Plan of the Heeleaka Experimental Station.	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association; and C. M. Hutchinson, Assistant Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
52	Green Manuring in Tea Culture in India .	Ditto ditto.	Ditto.

53	Factors determining the Quality of Tea .	Ditto ditto . .	Ditto.
54	Experiments in Heavy Pruning . .	Ditto ditto .	Ditto.
55	Report on the Heeleaka Experiments .	Ditto ditto .	Ditto.
56	Report on Sugar Mill at Benipur Factory .	Percy Jones	Behar Planters' Association, Mozufferpore.
57	A note on the results obtained with Java Indigo.	C. J. Bergtheil, Imperial Bacteriologist . .	Ditto.
58	A note on Testing the germinating capacity of Seeds.	Ditto	Ditto.
59	A note on Harvesting Java Indigo Seed .	Ditto	Ditto.
60	A note on the Treatment of Java Indigo Seed with Sulphuric Acid to promote germination.	Ditto	Ditto.
61	A note on Pruning Java Indigo . .	Ditto	Ditto.
62	Jute in rotation with Paddy in the same year. Leaflet No. 1 of 1907.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
63	Groundnut. Leaflet No. 2 of 1907 . .	Ditto ditto . .	Ditto.
64	Winter Rice. Leaflet No. 3 of 1907 .	Ditto ditto . .	Ditto.
65	Potatoes at Burdwan. Leaflet No. 4 of 1907	Ditto ditto .	Ditto.
66	Potatoes in rotation with Jute. Leaflet No. 5 of 1907.	Ditto ditto . .	Ditto.
67	Variety Experiment on Mustard at Dumraon Agricultural Station. Leaflet No. 6 of 1907.	Ditto ditto . .	Ditto.
68	Suggestions on the improvement of Silk reeling in Bengal. Price Re. 1-8-0.	N. G. Mukerji, M.A., M.R.A.C., F.H.A.S., Assistant Director of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
69	A Report on Sericulture in Baroda . .	N. G. Mukerji, M.A., M.R.A.C., F.H.A.S., Assistant Director of Agriculture, Bengal.	Government Press, Baroda.
70	A Report on Kashmir Silk Industry . .	Raojibhai B. Patel, M.R.A.C., M.R.A.S., Director of Agriculture and Industries, Baroda.	Ditto.
71	Monograph on the Cattle and Buffaloes of Burma.	Major G. H. Evans, F.L.S., I.C.V.D. . .	Government Printing, India, Calcutta.
72	Notes on indigenous breeds of Cattle in the Punjab.	Major H. T. Pease, I.C.V.D.	Ditto.
73	Manual of Irrigation Wells. Bulletin No. 22 of 1907. Department of Agriculture, United Provinces. Price 12 annas.	E. A. Molony, I.C.S.	United Provinces Government Press, Allahabad.
74	Conditions determining the area sown with crop in the United Provinces, Part I. Bulletin No. 23 of 1907. Department of Agriculture, United Provinces. Price 2 annas.	W. H. Moreland, C.I.E., I.C.S., Director, Department of Land Records and Agriculture, United Provinces.	Ditto ditto.
75	Note on Sugarcane. Bulletin No. 25 of 1905. Department of Agriculture, Bombay.	J. B. Knight, M.Sc., Professor of Agriculture, Bombay.	Government Central, Press, Bombay.
76	Cattle in the Bombay Presidency. Bulletin No. 26 of 1905. Department of Agriculture, Bombay. Price Rs. 8-4.	Major F. Joslen, Superintendent, Civil Veterinary Department, Bombay.	Ditto.
77	Date Palm. Bulletin No. 28 of 1906. Department of Agriculture, Bombay.	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture, Bombay.	Ditto.

78	The Bombay Cottons. Bulletin No. 29 of 1906. Department of Agriculture, Bombay. Price 10 annas.	Ditto ditto	Ditto.
79	The Statistical Atlas of the Bombay Presidency. Price 14 annas.	Department of Agriculture, Bombay . .	Ditto.
80	The Elements of Agriculture of the Bombay Presidency. Price Re. 1-4.	P. R. Mehta, M.R.A.C.	Government Central Book Depôt, Bombay.
81	Cultivation of Bersim or Egyptian Clover (intended for cultivation in Sind only).	F. Fletcher, M.A., B.Sc., Deputy Director of Agriculture, Bombay.	Department of Agriculture, Bombay.
82	Instructions for the sowing and after cultivation of Egyptian cotton (without ridging).	Ditto ditto . .	Ditto.
83	First Book of Agriculture. Price 12 annas.	C. Benson, M.R.A.C., Deputy Director of Agriculture, Madras.	MacMillan & Co., Ld., London.
84	Lift Irrigation. Price Rs. 2 . . .	Alfred Chatterton, Professor of Engineering, Madras.	G. A. Nateson & Co., Madras.
85	Report on Experiments in pumping with Oil Engines and Centrifugal Pumps in 1905-06.	Alfred Chatterton, Director of Industrial and Technical Enquiries in Madras.	Government Press, Madras.
86	Progress Report on the work of the Samalkota Farm during 1903-04, Bulletin No. 51.	Department of Agriculture, Madras . .	Ditto.
87	The Agathi Plant. Its growth in connection with the cultivation of the Betel vine which is trained thereon. Bulletin No. 52 of 1905. Madras Department of Agriculture. Price 9 pies.		

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
88	The cultivation and curing of Tobacco as followed near Dindigul, Madura District. Bulletin No. 53 of 1905. Madras Department of Agriculture. Price 3 annas.	Department of Agriculture, Madras . . .	Government Press, Madras.
89	Note on Irrigation by pumping from a well at Melrosapuram. Bulletin No. 54 of 1905. Madras Department of Agriculture. Price 3 annas.	Alfred Chatterton, Professor of Engineering, Madras	Ditto.
90	The Great Millet or Sorghum in Madras. Bulletin No. 55 of 1906. Madras Department of Agriculture. Price 3 annas.	C. Benson, M.R.A.C., Deputy Director of Agriculture, Madras, and C. K. Subba Rao, B.A., Sub-Assistant Director of Agriculture, Madras.	Ditto.
91	The Sunflower. Price 1 anna 6 pies . .	Department of Agriculture, Madras . . .	Ditto.
92	Some suggestions for Madras Ryots. Bulletin No. 3 of 1906. Price 2 annas 9 pies.	The Central Agricultural Committee, Madras .	Ditto.
93	The use of Prickly Pear as fodder. Bulletin No. 4 of 1906 Price 3 pies.	Ditto ditto . .	Ditto.
94	Squash. Bulletin No. 15 of 1906. Department of Agriculture, Eastern Bengal and Assam.	Department of Agriculture, Eastern Bengal and Assam.	Secretariat Press, Shillong.
95	Proceedings of the Agri-Horticultural Society of Madras (Quarterly, 1906).	Ditto ditto . .	Higginbotham & Co., Madras.

96	Journal of the Agri-Horticultural Society of Western India (Quarterly, 1906).	Honorary Secretaries, Poona	Scottish Mission Industries Company, Ld., Poona.
97	Experiments with Aman Paddy. Bulletin No. 1 of 1907.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Bengal Secretariat Press.
98	List of the Principal Economic Plants grown in Bengal. Price 7 annas.	Department of Agriculture, Bengal . . .	Bengal Secretariat Book Depôt.
99	Manual of Arboriculture . . .	Ditto	Bengal Secretariat Press.
100	Report on the Sugarcane Industry of Bengal.	Ditto	Ditto.
101	Report on the possibility of extending well irrigation in Behar and Chota Nagpur. Price 12 annas.	N. N. Banerjea, B.A., M.R.A.C., F.H.A.S., M.R., A. S.I., Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt.
102	Note on the Production of Coffee in India in the year 1906. Price 4 annas.	Office of the Director General of Commercial Intelligence.	Superintendent, Government Printing, India, Calcutta.
103	Production of Tea in India, 1906. Price 8 annas.	Ditto ditto .	Ditto ditto.
104	Note on the cotton failure on account of boll-worm in the Central and South-West Punjab in 1905 and on the results of the measures taken to prevent a recurrence in 1906. Bulletin No. 1 of 1907. Price 2 annas.	W. Benouf, C.S., Director of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
105	Jute. Leaflet No. 1 of 1906 . . .	Department of Agriculture, Bengal . . .	Bengal Secretariat Press, Calcutta.
106	Note on Agricultural Experiments suitable for the Bhagalpur Division. Leaflet No. 2 of 1906.	C. A. Oldham, I.C.S., Director of Agriculture, Bengal.	Ditto.
107	Suggestions on the Cultivation of Cotton. Leaflet No. 3 of 1906.	N. G. Mukerji, M.A., M.R.A.C., Assistant Director of Agriculture, Bengal.	Ditto.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		General Agriculture—concld.	
108	A Short Note on Jute for Cultivators. Leaflet No. 4 of 1906.	Department of Agriculture, Bengal . .	Bengal Secretariat Press, Calcutta.
109	Short Note on Cotton for the use of Cultivators. Leaflet No. 6 of 1906.	Ditto	Ditto.
110	Simple instructions for the destruction of Insects attacking Jute. Leaflet No. 7 of 1906.	Ditto	Ditto.
111	Instructions in regard to Cotton Picking. Leaflet No. 8 of 1906.	Ditto	Ditto.
112	Short Note on Potato Cultivation for cultivators. Leaflet No. 9 of 1906.	Ditto	Ditto.
113	Teaching of Experiment work at the Burdwan Station. Leaflet No. 10 of 1906.	Ditto	Ditto.
114	A simple method of destroying the Red Cotton Bug which is now found in large quantities on the Cotton near Jamtara. Leaflet No. 11 of 1906.	Ditto	Ditto.
115	Jute Experiment, Cuttack, 1906 . .	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Ditto.
116	Jute Experiment, Burdwan, 1906. Leaflet No. 12 of 1906.	Ditto ditto . .	Ditto.

Agricultural Chemistry.

1	Annual Report of the Agricultural Chemist to the Government of Mysore for the year 1904-05.	A. Lehmann, M.A., B.S.A., Ph.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
2	Annual Report of the Agricultural Chemist to the Government of Mysore for the year 1905-06.	Ditto ditto . .	Ditto " ditto.
3	Phaseolus Lunatus (Lima or Duffin Bean). A Report on the Chemical examination of Beans. Agricultural Ledger No. 2 of 1905. Price 2 annas.	Wyndham R. Dunstan, F.R.S., Director of Imperial Institute, London.	Government Printing, India, Calcutta.
4	Saltpetre. A Report on the Manufacture of Indian saltpetre. Agricultural Ledger No. 3 of 1906. Price 6 annas.	D. Hooper, F.I.C., F.C.S., Superintendent, Industrial Section, Indian Museum, Calcutta.	Ditto.
5	The Fermentation of Tea, Part I . .	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
6	The rate of Hydrolysis in the Septic Tank .	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.	Paper road at the 6th International Conference of applied Chemistry, Rome, 1906.
7	The Agricultural Research Institute, Pusa .	Ditto ditto . .	Ditto ditto.
8	The supply of nitrate to the surface soil from the underground water. Price 5s.	Ditto ditto . .	The Journal of Agricultural Science, Cambridge, Vol. I, Part 4.
9	Some preliminary notes on the physical properties of the soil of the Ganges Valley, more especially in their relation to soil moisture.	H. M. Leake, M.A., F.L.S., Economic Botanist to the Government of the United Provinces of Agra and Oudh.	Ditto ditto.
10	The fermentation of the Indigo Plant .	C. J. Bergtheil, Imperial Bacteriologist . .	Transactions of the Chemical Society, 1904. Vol. 85.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		Agricultural Chemistry—contd.	
11	The Determination of the Indigotin in Commercial Indigo yielding plant.	C. J. Bergtheil, Imperial Bacteriologist . .	Journal of Society of Chemical Industry. Vol. XXV, page 729.
12	The Composition of Indian Rain and Dew. Price Re. 1.	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist.	Memoirs of the Department of Agriculture in India, Vol. I, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
13	The Composition of Oil Seeds. Price Re. 1	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
14	The Potculture House at the Agricultural Research Institute, Pusa, Part I. Price Rs. 3.	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. 1, No. 3. Messrs. Thacker, Spink & Co., Calcutta.
15	Experiments on the availability of Phosphates and Potash in soils, Part I. Price Re. 1-8.	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 4. Messrs. Thacker, Spink & Co., Calcutta.
		Botany.	
1	Bearing of Mendelism on the susceptibility of wheat to rust. Price 5*s*.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Journal of Agricultural Science, Cambridge, Vol. I, Part III.
2	The Blister Blight of Tea . . .	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
3	Agave and Furcræa, spp Agricultural Ledger No. 7 of 1906. Price Re. 1-8.	J. R. Drummond and D. Prain . . .	Office of the Superintendent, Government Printing, India, Calcutta.

4	The varieties of cultivated pepper. Bulletin No. 56, Vol. III of 1906. Madras Department of Agriculture. Price 3 annas.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Government Press, Madras.
5	Some results of acclimatization work at Saharanpur Botanical Gardens. Bulletin No. 21 of 1906. Department of Agriculture, United Provinces. Price 2 annas.	W. Gollan, Superintendent of Gardens, Saharanpur.	Government Press, Allahabad.
6	First Report on the Fruit Experiments at Pusa. Bulletin No. 4 of the Agricultural Research Institute, Pusa. Price 6 annas.	Albert Howard, M.A. (Cantab.), A.R.C.S. (Lond.), F.C.S., F.L.S., Imperial Economic Botanist.	Government Printing, India, Calcutta.
7	The Haustorium of Santalum Album I. Early stages, up to Penetration. Price Re. 1.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Memoirs of the Department of Agriculture in India, Vol. I, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
8	Indian Wheat Rusts. Price Rs. 3 . .	E. J. Butler, M.B., F.L.S., Imperial Mycologist, and J. M. Hayman, Deputy Director of Agriculture, United Provinces.	Memoirs of the Department of Agriculture in India, Vol. I, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
9	Fungus Diseases of Sugarcane in Bengal. Price Rs. 3.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Memoirs of the Department of Agriculture in India, Vol. I, No. 3. Messrs. Thacker, Spink & Co., Calcutta.
10	Gossypium Obtusifolium, Roxburgh. Price Re. 1.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India.	Memoirs of the Department of Agriculture in India, Vol. I, No. 4. Messrs. Thacker, Spink & Co., Calcutta.
11	An account of the Genus Pythium and some Chytridiaceæ. Price Rs. 4-8.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Memoirs of the Department of Agriculture in India, Vol. I, No. 5. Messrs. Thacker, Spink & Co., Calcutta.
12	Cephaleuros Virescens, Kunze: The Red Rust of Tea. Price Rs. 4.	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association, and C. M. Hutchinson, Assistant Scientific Officer to the Indian Tea Association.	Memoirs of the Department of Agriculture in India, Vol. I, No. 6. Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—contd.

No.	Title.	Author.	Where published.
		Botany—contd.	
13	Some Diseases of Cereals caused by Sclerospora Graminicola. Price Re. 1-8-0.	E. J. Butler, M.B., F.L.S., Imperial Mycologist .	Memoirs of the Department of Agriculture in India, Vol. II, No. 1. Messrs. Thacker, Spink & Co., Calcutta.
14	Studies in Root Parasitism. The Haustorium of Santalum Album. Part 2.—The structure of the mature Haustorium and the inter-relations between Host and Parasite. Price Rs. 3.	C. A. Barber, M.A., F.L.S., Government Botanist, Madras.	Memoirs of the Department of Agriculture in India, Vol. I, No. 1, Part II. Messrs. Thacker, Spink & Co., Calcutta.
15	Notes on Agave and Furcræa in India. Bulletin No. 8. Agricultural Series No. 7. Price Re. 1.	J. R. Drummond and D. Prain	Bengal Secretariat Book Depôt, Calcutta.
16	Report on trials of the South African Locust Fungus in India. Bulletin No. 5 of 1907. Agricultural Research Institute, Pusa. Price 2 annas.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, and H. M. Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Government Printing, India, Calcutta.
		Entomology.	
1	An outbreak of Cotton Pests in the Punjab, 1905. Bulletin No. 2 of the Agricultural Research Institute, Pusa.	H. M. Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
2	The Indian Insect Pests. Price Re. 1-8 .	Ditto ditto . .	Ditto.
3	The Bombay Locust. Price Rs. 2-8 .	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 1. Messrs. Thacker, Spink & Co., Calcutta.

4	The more important Insects injurious to Indian Agriculture. Price Rs. 3.	Ditto ditto . . .	Memoirs of the Department of Agriculture in India, Vol. I, No. 2. Messrs. Thacker, Spink & Co., Calcutta.
5	The Indian Surface Caterpillars of the Genus Agrotis. Price Re. 1-8.	Ditto ditto and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Memoirs of the Department of Agriculture in India, Vol. I, No. 3. Messrs. Thacker, Spink & Co., Calcutta.
6	Individual and seasonal varieties in Helopeltis Theivora, Waterhouse, with description of a new species of Helopelties. Price Re. 1-8.	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Memoirs of the Department of Agriculture in India, Vol. I, No. 4. Messrs. Thacker, Spink & Co., Calcutta.
7	The Coccidæ attacking the Tea Plant in India and Ceylon. Price Re. 1.	E. E. Green, F.E.S., Government Entomologist, Ceylon, and Harold H. Mann, D. Sc., Scientific Officer to the Indian Tea Association.	Memoirs of the Department of Agriculture in India, Vol. I, No. 5. Messrs. Thacker, Spink & Co., Calcutta.
8	Rice Grasshopper. Bulletin No. 27 of 1906. Bombay Department of Agriculture.	J. B. Knight, M.Sc., Professor of Agriculture, Bombay, Poona, and R. M. Dixon, B.A., Entomological Assistant, Bombay.	Government Central Press, Bombay.
9	Red Slug Caterpillar (a serious Pest of the Tea Plant).	Harold H. Mann, D.Sc., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
10	The Mosquito Blight of Tea, Part III . .	Ditto ditto .	Ditto.
11	Notes on Entomology. Bulletin No. 1 of Mysore Department of Agriculture.	A. Lehmann, M.A., B.S.A., Ph.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
12	Destruction of Fleas by Insecticides. Leaflet. Agricultural Research Institute, Pusa.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Government Printing Press, Calcutta.
13	Useful Insects. (Leaflet.) Agricultural Research Institute, Pusa.	Ditto ditto .	Ditto.
14	Household Insects. (Leaflet.) Agricultural Research Institute, Pusa.	Ditto ditto .	Ditto.

List of Agricultural Publications in India during 1905-06 *and* 1906-07—concld.

No.	Title.	Author.	Where published.
		Entomology—contd.	
15	Direction for sending insect specimens. (Leaflet.) Agricultural Research Institute, Pusa.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Government Printing Press, Calcutta.
		Bacteriology.	
1	A note on the Inoculation of the soil for leguminous crop. Bulletin No. 1.	C. J. Bergtheil, Imperial Bacteriologist	Indigo Research Station, Sirsiah, Mozuffer-poro.

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REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1907-09

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CALCUTTA
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TABLE OF CONTENTS.

Sections.		Page.
1.	Charge of Office and Duties	1
2.	The Staff and Means for Agricultural Improvement in India.	1
3.	Rules of Service	2
4.	Tours	3
5.	Board of Agriculture	5
6.	Agricultural Research Institute, Pusa	6
7.	Agriculture	8
8.	Botany	10
9.	Agricultural Chemistry	12
10.	Mycology	12
11.	Entomology	14
12.	Cotton	17
13.	Tree Cottons	21
14.	Wheat	22
15.	Groundnut	23
16.	Sugarcane	25
17.	Tobacco	27
18.	Indigo	28
19.	Jute	29
20.	Flax	31
21.	Other Fibres	32
22.	Tea	33
23.	Cassava	34
24.	Artificial Fertilizers	36
25.	Distribution of Seeds	37
26.	Distribution of Implements	39
27.	Irrigation	40
28.	The Reclamation of Alkali or Reh Lands	44
29.	Sericulture	44
30.	Poultry-breeding	47
31.	Agricultural Education	47
32.	Publications	49
33.	Expenditure	50
34.	Expansion of the Department	51
Appendix A.—	The Agricultural Staff and work in each Province.	53
,, B.—	Indigo Research Work in Behar	58
,, C.—	List of Agricultural Publications in India during 1907-08 and 1908-09.	60

REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1907-09

1. *Charge of Office and Duties*—I held charge of the office of Inspector-General of Agriculture in India during the period under report. In the discharge of my duties I was cordially assisted by the provincial Directors of Agriculture who readily accepted advice. Mr. T. F. Main, B.Sc., held the post of Assistant Inspector-General of Agriculture in India till 14th September 1907. He was then transferred to Bombay as Deputy Director of Agriculture, owing to the special pressure of work in that province. The post remained vacant during the remainder of the period under report. The sanction of the Government of India has recently been obtained to the appointment of Mr. E. Shearer, M.A., B.Sc., as Assistant Inspector-General of Agriculture in India. My office head-quarters will probably be in future at Pusa where Mr. Shearer will be in residence. He will be responsible for the direction of routine office work, will continue to be in charge of cattle, sheep and poultry-breeding at Pusa and will take up special agricultural enquiries in the provinces from time to time. One big line of his work which may occupy at least two years will be the preparation of a text-book on agriculture suitable for students in each agricultural college in India.

2. *The Staff and Means for Agricultural Improvement in India*—In the Imperial Department of Agriculture the scientific staff as limited by the orders of the Secretary of State has been complete for the first time and now consists of 16 European officers and the sanctioned number of

Indian assistants. Mr. G. A. Gammie, F.L.S., an experienced officer of the Bombay Department of Agriculture, was appointed Imperial Cotton Specialist in December 1907. His head-quarters have been temporarily located at Poona. The Second Imperial Entomologist, Mr. F. M. Howlett, B.A., after specialising in England, arrived at Pusa in December 1907 and commenced his investigations in connection with his special entomological lines of work. The Supernumerary Mycologist arrived at Pusa on the 31st March 1908, after finishing special studies in Germany. The Imperial Bacteriologist (Mr. C. J. Bergtheil) remained on deputation at Sirsiah, Behar, till 31st March 1909, and was employed in research work on indigo. He returned to Pusa on the 1st April 1909, and has since resigned the Indian Agricultural Service to take up private service under the Behar Planters' Association. Mr. A. G. Birt, Supernumerary Agriculturist, was sent in June 1908, to officiate as Assistant Director of Agriculture, Eastern Bengal and Assam, where it is understood, he will be appointed as Second Deputy Director of Agriculture. Mr. W. Roberts continued to assist the Bombay Department of Agriculture. On account of the continued illness of Mr. Garrad, the Government of India were constrained to give him notice of termination of engagement. Another Agriculturist, Mr. Sherard, has been appointed in his place.

The Planters' Associations in Behar and Southern India have each a staff of agricultural experts. The United Southern India Planters' Association have recently engaged Mr. Anstead as their Agricultural Adviser. Dr. L. C. Coleman has been appointed by the Mysore Durbar as Mycologist and Entomologist. Dr. Lehman, the Chemist, has left the service of the Mysore State. The departments of agriculture in the Baroda and Kashmir States are developing slowly.

3. *Rules of Service*—In order to place the Agricultural Service in India on a uniform basis, rules regulating the emoluments and conditions of the Agricultural Service have been revised. Local allowances of Rs. 100 rising to Rs. 200 have been sanctioned for senior officers in the

Imperial Department of Agriculture in addition to the regular graded pay of the Service, Rs. 500—50—1,000.

The pay and prospects of the higher subordinate staff at Pusa have been improved, and it is under consideration to improve their official status by granting gazetted rank to those doing responsible work intended to lead to research work. The provincial departments are also improving the pay and prospects of the subordinate agricultural service, but throughout this service substantially better rates of pay will have to be offered, or the best class of Indian assistants will not be attracted to the departments.

4. *Tours*—During the period under report I visited all the provinces except Eastern Bengal and Assam and the North-West Frontier Province. I have endeavoured to keep in close touch with all the provincial agricultural work which is in progress. I offered advice to local officers in a general way on all agricultural matters and, in particular, on the selection of lands for experimental farms and upon their equipment for useful work.

I attended the agricultural conference at Ahmedabad in November 1907, and on the same tour and on other occasions, inspected all the experimental stations in Bombay Presidency, also the temporary laboratories and new college at Poona. Advice was sought by the Director of Agriculture, Bombay, in connection with the contemplated experiments for the reclamation of alkali ("reh") lands in Sind. The land selected for reclamation at Daulatpur (near Mirpurkhas) was inspected, and the methods of reclamation discussed. I promised to pay half the cost of reclamation from Imperial funds, the work and payments extending over three years. The area at present dealt with extends to 400 acres. It was absolutely sterile. In all likelihood it will soon be abundantly fertile. Advantage was taken of this tour to inspect the cultivation of Egyptian cotton in Sind chiefly under the Jamrao canal. In the Punjab I visited the Lyallpur farm several times and inspected the system of cultivation followed in the new canal colonies. In company with Messrs. Milligan and Barnes I saw a good deal of deterioration caused by "reh". In this

connection the villagers were very solicitous to obtain help. I gave advice to the Director of Agriculture on the starting of the agricultural college and in regard to the working of the college farm, botanical area, etc. In October 1908, I toured slowly through Kulu and the Kangra valley to study the agricultural possibilities of these parts—the trade and the fruit and tea industries. A descriptive illustrated article on this tour will appear in the *Agricultural Journal of India.*

I attended the meeting of the veterinary conference held at Calcutta in February 1908. In company with the Director of Agriculture, Bengal, and some members of his agricultural staff, I saw all the Bengal farms, also those maintained at Burdwan and Dumraon. I attended the ceremony of laying the foundation stone of Sabour Agricultural College. The extensive flax experiments at Dooriah factory in Behar were inspected, and I made arrangements on the spot for their continuance for five years, my department paying half the salary of the expert officer who is in charge of the work. I camped at Pusa for lengthy periods on many occasions. The general improvement and equipment of the estate were discussed with the Director, and in personal discussion with the experts of the different sections, various important questions connected with the administration, experiments and research work of the institute, were settled. I have seen on several occasions something of the research work in indigo which is in progress at Sirsiah under Mr. Bergtheil, and in connection therewith, have met a good many of the leading indigo planters.

In Madras the interesting and valuable sugarcane experiments at Samalkota were inspected. In company with the Director and some of his staff, a visit was paid to Koilpatti, Taliparamba, Coimbatore, Palur, Bellary and other farms, and the aims of the agricultural work done by the department were fully discussed. During this tour I saw a great deal of the general agriculture in Madras.

I inspected Nagpur, Telinkheri, Akola, and Raipur farms of the Central Provinces in February last, and

amongst other things was much impressed with the way in which Mr. D. Clouston has arranged for the training of orphan famine boys in ordinary agricultural work, in rough carpentry and black-smith's work. I should like very much to see these young men back on to the land in small colonies, helped by *takavi* advances from Government.

I was only able to tour for a short period in the United Provinces. I hope to see a good deal of this province this autumn and also of Eastern Bengal and Assam.

5. *Board of Agriculture*—The proceedings of the fourth meeting of the Board of Agriculture which was held at Pusa in February 1908, have been separately published in full detail. The meeting was attended by 51 members as against 48, 35 and 32 members in the preceding three years. The subjects for discussion were (1) the form of report of the Board's proceedings; (2) the future constitution of the Board of Agriculture; (3) the programmes of work of the Imperial and provincial departments of agriculture, as well as those of Mysore, Baroda and Kashmir States; (4) the lines of carrying on entomological and mycological work in the provinces, and the general expansion of the different sections of the provincial departments of agriculture; (5) the best methods of bringing experimental work to the notice of cultivators; (6) the extension of cultivation of fibre plants; (7) the scope of improved poultry-breeding in India; and (8) the syllabus of studies in the Pusa and provincial colleges. Mr. H. E. Abbot, Editor of the *Indian Fowl Fanciers', Gardeners' and Farmers' Gazette,* attended the meeting as a visitor and gave much valuable information on the scope of poultry-breeding in India. The constitution of the Board of Agriculture has been revised by the Government of India and is now limited to 38 members. The fifth meeting of the Board of Agriculture was held at Nagpur on the 15th of February 1909, and the following days. The proceedings have been published. 36 members and 8 visitors attended the meeting. The subjects of discussion were (1) the programmes of work of the Imperial and provincial departments of Agriculture as well as those of Mysore, Kashmir and Baroda

States; (2) the best means of bringing the results of experimental work in agriculture to the notice of cultivators; (3) touring of agricultural experts outside their own provinces; (4) agricultural education; (5) introduction of good indigenous methods of cultivation, implements and crops; (6) agricultural stations, demonstration areas and seed farms; (7) training of Indian officers for the management of agricultural stations; and (8) dissemination of the work and aims of the agricultural department through the Press. The report on the best methods of introducing improvements into Indian agriculture as amplified from information supplied by provincial Directors was referred to this Board. It has been revised by the committee of which Dr. H. H. Mann was chairman, and after scrutiny by the President of the Board, is being published in pamphlet form and will be very widely distributed. The Honourable the Chief Commissioner of the Central Provinces attended the meeting on the last day and made a powerful speech on this subject. The amplified report of the committee appointed to consider the question of extensive cultivation of fibre plants in India, was also submitted to this year's Board of Agriculture. It is now in the press.

6. *Agricultural Research Institute, Pusa*—The reports of the Director and the various officers of this Institute are published in a separately printed report which is issued simultaneously with this report. I here only describe some of the lines of work in each section particularly in regard to their application to the improvement of ordinary Indian agriculture.

The Director returned from nine months' combined leave on the 27th November 1907, and for the remainder of the period under report, was in charge of his office.

Drs. J. W. Leather and E. J. Butler proceeded on leave from the 15th and 1st April 1909, respectively, and Messrs. H. E. Annett and W. McRae have been appointed to officiate for them. The post of Imperial Bacteriologist is now vacant as Mr. C. J. Bergtheil has resigned. I have made proposals regarding his successor.

All the sections have moved from the temporary laboratories to the Phipps laboratory. The Institute is now equipped with all necessary fittings and apparatus in each section and is served with water power and electric installations.

A new approach avenue to the Institute has been constructed, and the lawns surrounding the College building have been laid out and sparsely planted with trees and ornamental shrubs. The amenities of the estate have been much improved in many ways, particularly by clearing scrub growth, thus making preparation for bringing waste land under cultivation. The brick-fields near the entrance to the estate have been levelled and are now under cultivation with suitable ordinary crops. An area of some 150 acres has been reclaimed for arable cultivation. Practically the whole of the estate is now under grass or cultivation.

Additional means of irrigation from the little Gundak river which bounds the estate on three sides, have been provided for the lawns and for the vegetable and botanical gardens.

It has been proved in the past that the estate is capable of growing very fine timber trees in the avenues and elsewhere. Consequently the frontage on the river will be improved throughout the entire length of the estate by suitable trees, and the avenues and grazing grounds on the estate will also be similarly improved. The existing teak, shishum, bamboo and mahogany avenues are an object lesson to many parts of India, but we even expect to improve on these. Many suitable trees on the river side lands have been inoculated with lac.

It has been definitely settled that Pusa shall only be chiefly a higher teaching institution with post-graduate studies and especially open for admission to selected graduates of provincial agricultural colleges and distinguished science graduates of Indian universities. A prospectus of the Pusa College has been published for general information. Specialization is only allowed at Pusa in one of the following subjects at a time:—agriculture, economic botany, agricultural chemistry, mycology

and entomology. Arrangements have been made for the time being to give in agriculture, economic botany, and entomology, short courses particularly in regard to the practical application of these sciences to every-day agriculture or horticulture in India.

Nineteen students in the various sections were admitted for training last year. Of these 3 were for general training, 3 in mycology, 7 in entomology, 2 in economic botany, 2 in agricultural chemistry and 2 in agriculture. In regard to the scientific and practical work at Pusa my chief desire is that the teaching in the lecture room, in the laboratories and in the field, should be a means of helping, in a very practical way, the ordinary or improved agriculture of this country. I wish, therefore, to attract from provincial agricultural colleges and from other colleges, students of high class ability who have been reared on the land. Such students if thoroughly trained at Pusa could exercise an enormous influence on the improvement of Indian agriculture. Many of these are poor and cannot afford the expense of superior education. Government have spent of late years large sums on the development of agriculture, and I am confident that Indian gentlemen generally interested in the work will do their share. There is perhaps no direction in which there is more scope for liberality of the most useful kind than in the founding of scholarships for students at Pusa.

The Pusa library at present contains about 6,000 volumes. Arrangements have been made to lend to officers of the provincial departments of agriculture books from the library on certain conditions.

The medical arrangement at Pusa is now working fairly satisfactorily. During the period under report relief was given to a large number of both indoor and outdoor patients.

7. *Agriculture*—Mr. E. Shearer, Imperial Agriculturist, has done much useful work for the Department. He was absent on privilege leave from 2nd July to 30th September 1908, when his duties were carried on by the Director.

Permanent manurial and rotation experiments were laid down last year on two blocks of 9 acres each. The land selected for these experiments has been tested and found sufficiently uniform for the purpose.

Permanent pasture experiments were laid down in the monsoon of 1907. It is very important to know the best conditions in various parts of India under which pastures can, on practical lines, be properly established and improved. This is the aim of the Pusa experiments, and it is believed that the results will be of very wide application especially as similar grass experiments have been undertaken in some provinces. Already there is a decided change in the character of the herbage in some of the manured plots at Pusa.

Arable areas which are likely to be suitable for the extension of experimental work in the future, are being treated uniformly in regard to cultivation and cropping.

The more important crops under trial at Pusa include wheat, barley, oats, maize, rice, various pulses, oil seeds, sugarcane, jute, flax and tobacco. Efforts are being made to obtain and acclimatise the best indigenous and foreign varieties of these crops. Cotton varieties have been given up, as nearly all are unsuitable to Behar.

Perhaps the most important line of work in the agricultural section at Pusa refers to the breeding and rearing of farm live stock. A very select herd of Montgomery cattle, the premier milk-breed of India, is maintained. A record of the milk yield of each cow is kept. It is hoped to raise the milking standard (which is now very high) by selection on the basis of these records, and to breed these cattle of one colour and of one type. I draw attention to an interesting illustrated note which will appear in the October number of the *Agricultural Journal of India* for 1909. It refers to a large and remunerative export trade in Indian cattle which has recently arisen. Probably no Indian breed will meet the requirements of this foreign demand better than Montgomery cattle. They are useful for milk, for work and for beef, and in South Africa, in the Southern States of America and in the Straits Settlements they must prove

useful, because pure and half-bred Indian cattle have been found to thrive well in these parts and are not affected by flies and ticks in the same disastrous way as local cattle.

Last cold weather 80 Bikanir ewes were purchased. These are a white-fleeced breed with a high reputation for yield and quality of wool. They are being crossed by *dumba* rams to give them hardiness and obtain improvement in the crosses as mutton and wool sheep.

Poultry-breeding is now conducted on a fairly large scale. During the last year 19 breeding pens of fowls representing 10 pure breeds and 3 crosses, have been maintained including turkeys, geese and ducks. The experience so far gained indicates that the breed of fowl fully suited to India will have to be developed by crossing. With this aim in view various experiments are being tried at Pusa. Many enquiries are received for pure bred birds and for eggs for hatching. The farms in several provinces have been supplied with birds, and large orders are being booked from private individuals, chiefly in Madras and Burma. Some of the pure and cross breeds reared at Pusa are being tried experimentally in the hills to determine how they stand the climate.

8. *Botany*—Mr. A. Howard has done a great deal of useful work for the agriculture and horticulture of India.

He continued to be in charge of his section except when he was on leave for six months from August 8th, 1907, to February 8th, 1908, when Mr. R. J. D. Graham, Supernumerary Economic Botanist, carried on the work of the section.

The most important work done by Mr. Howard during the period under report is in relation to wheat. He has nearly completed the botanical survey of the wheats of India. The results are given in the first section of his book, *Monograph on Indian Wheats* now in the press. Samples of wheat were sent to Mr. Humphries in England for milling and baking tests, the results of which are published in a bulletin. At Pusa several promising wheats have been isolated by selection and are now being tested for yield, agricultural characters and grain qualities.

The plant breeding work in wheat is now being conducted on a fairly large scale, and the separate cultures, many hundreds in number, extend over several acres. The main objects of this hybridization work are to improve the grain, straw and rust-resistance of the Indian wheats. Considerable progress has been made in the investigation into the influence of soil, climate and moisture on the character of the grain in wheat.

Fruit cultivation, on an extensive scale, has been successfully established. Most of the fruit trees are coming into bearing. The fruit experiments at Pusa have already yielded results of considerable practical importance. They have proved the suitability of the soil and climate in Behar for growing certain important varieties of fruit.

Preliminary experiments with high class fruit regarding sun drying, evaporating and refrigerating, have been carried out. A method was devised and successfully tested for sending peaches long distances by rail in India.

During the past year a considerable amount of preliminary work was accomplished by Mr. Howard on oil seeds of the genus *Brassica*, and a general study of the oil seeds of India will be undertaken.

The races of both *Nicotiana rustica* and *Nicotiana tabacum* isolated at Pusa, have been studied. Arrangements have been made with the Peninsular Tobacco Company of Monghyr to conduct experiments at Pusa to ascertain the best varieties and the best means of growing tobacco suitable for the manufacture of cigarettes.

Selection experiments with flax, *Hibiscus cannabinus* and *Crotalaria juncea*, were continued, and some promising races isolated.

Three varieties of sisal hemp *(Agave rigida sisalana)* have been established on a small scale.

Progress has been made in the investigation work with barley, *ganja* and opium. The study of the varieties of cassava has been completed, and Mr. G. P. Hector is preparing a final report on this subject.

9. *Agricultural Chemistry*—Dr. Leather held charge of this section till 14th April 1909 when he went on leave, and the Supernumerary Agricultural Chemist, Mr. H. E. Annett, was appointed to officiate for him. Very few samples of agricultural materials are now sent up by provincial departments for analyses, as these departments have now their own chemists. An appreciable reduction has also taken place in the number of samples received from Native States, the forest and irrigation departments and private persons. Dr. Leather had, therefore, more time for original research and for larger investigations of importance to Indian agriculture generally.

The work in the pot-culture house has led to important field experiments, the results of which are likely to benefit cultivators at least in Behar in a very substantial way. These field experiments are devised to show that phosphatic manures can, with economy and great advantage, be used for certain soils and many crops particularly in parts of the Gangetic alluvium and especially in Behar.

The Imperial Agricultural Chemist has a very important investigation in progress on the effect of soil or manure on the composition of certain seeds. The results already obtained are remarkable. In conjunction with the Imperial Entomologist, Dr. Leather is investigating the prevention of injury by weevils to wheat and other grains when stored in bulk. This enquiry is of great importance, particularly as it is probable that the American "elevator system" of storing grain may be introduced into India at least on an experimental scale. Mr. Annett has conducted an interesting enquiry into the cause of the dark colour of the black cotton soil. The results of this enquiry are about to be published.

10. *Mycology*—Dr. E. J. Butler held charge of this section till 31st March 1909, when the Supernumerary Mycologist, Mr. W. McRae, M.A., B.Sc., was appointed to officiate for him. Mr. McRae arrived in India after deputation for six months to the laboratory of Professor von Tubeuf at Munich. The transfer of the laboratories to the Phipps building has greatly facilitated the work of this section.

Dr. Butler should be congratulated in regard to the practical application of his work to the ordinary conditions of Indian agriculture.

The requirements of provincial departments still continue to make heavy calls upon the time of the Imperial Mycologist. Collections are being accumulated and worked out with such voluntary assistance as can be got outside India. Duplicate collections will be as far as possible supplied to provincial departments which already have mycological assistants.

The fungi hitherto recorded from India have been, in great part, identified, and the information has been made readily accessible.

The research work includes the examination of the life-history and general biology of parasites and their effects on the attacked plants.

The wilt diseases of cotton, indigo, pigeon pea and gram were selected for special study, and the results already obtained will largely help Indian agriculture. A memoir on the work is now in the press. The experiments at the Poona farm to raise a strain of pigeon pea resistant to the wilt disease, have been in progress for four years and are promising well.

Renewed experiments were made to elucidate the methods of infection of the red-rot disease of sugarcane, which in India has been for a considerable period a very disastrous disease to this important crop. It is hoped that the new results will be published during the year, and advice of importance given. The study of the life-history of other sugarcane parasites has not yet reached the publication stage.

Dr. Butler inspected the palm disease operations in the Godavari delta, in September and December 1907 and in January 1909. Successful inoculations with the parasite were secured during 1908, and a further study of its life history was made. The campaign against this disease has been particularly successful and is still being prosecuted earnestly by means of the special staff sanctioned by the Madras Government. I must note the fact that the results

of this enquiry by Dr. Butler are so valuable to India that they are equivalent to saving the cost of his section to India for many years to come.

The Imperial Mycologist visited Travancore in September and October 1907 to investigate the cocoanut palm disease that had broken out in that State. A report on that disease has been published.

The Imperial Mycologist visited Kashmir in 1908 during the months of July, August and September, and enquired into diseases of mulberry and of imported fruit trees. The result of part of this work has been published, and recommendations made for dealing with mulberry diseases. The problem is very important, as many poor people in Kashmir derive much benefit from the silk operations and from the cultivation of good kinds of fruit.

Dr. Butler will complete, in a short time, the text of a book on Indian plant diseases. It will be of great value to students of agriculture in India.

11. *Entomology*—Mr. Lefroy held charge of this section during the period under report. His indomitable energy appears throughout the work of his section. He continued to direct the work of entomological assistants in the provinces, but their number is still only 13, which is quite inadequate to make an appreciable impression upon the agriculture of India. A beginning only has been made.

The teaching of entomology at the provincial agricultural colleges and also at demonstrations and at shows, has made fair progress.

Attention has been given in provinces to the study of the life-histories and habits of injurious insects.

In the Punjab the effects of cotton boll-worm and its parasites have been closely watched.

The work on the insects of the plains of India was continued.

Assistance was given to firms dealing with *mohwa*, with brush making and with cheroots in regard to insects damaging these articles.

Valuable results have been obtained in the cultivation of *eri*-silk during the past year on a small scale at Pusa,

and it is intended to continue this as the basis of a small cottage industry in several parts of India. This industry is being taken up in Tirhoot and Gujarat. The purely experimental work on *eri*-silk is almost completed. The cultivation of mulberry silk has been taken up.

The question of *tussar* silk is also being investigated.

The cultivation of lac was continued at Pusa as a demonstration to students and for much wider practical application in villages. Some owners of indigo factories in Behar have taken up lac cultivation on a fairly large scale. These men were supplied with seed and information, and their assistants were trained in lac culture. Assistance was also given to the Bikanir State in regard to the possibilities of lac culture there.

Mr. Lefroy has started apiculture with a few stocks of European bees to determine how far they thrive in the plains of India.

The Supernumerary Entomologist, Mr. Mason, visited the various centres at which army stores are baled and stored, to investigate the occurrence in clothing, etc., of the destructive insects, *Anthrenus vorax*. On the completion of this enquiry recommendations were made for better baling. Mr. Mason continued the enquiry into the value of insect-eating birds.

The general collection of insects of India apart from the purely economic one, has been completely arranged.

Enquiry into the question of preventing the introduction of fungus and insect pests by importation of plants and seeds, was made in order to devise remedial measures.

The text-book on *Indian Insect Pests* continues to increase in popularity. Its translation in Bengali has been prepared.

Mr. Lefroy's great work on *Indian Insect Life* has been issued.

A series of excellent coloured plates with short printed explanations illustrating injurious insects, have been issued for use in agricultural colleges, museums and farms and at exhibitions and shows. This series will be continued and will cover silk, lac, bees and beneficial insects.

The best methods of preparing exhibits of injurious insects for shows, are also being tested with a view to find out the class of exhibits that most appeal to the public. Further, a series of lantern slides in colour are being prepared in order that lantern lectures may be given at such shows.

Mr. F. M. Howlett, Second Imperial Entomologist, arrived at Pusa in December 1907. He has undertaken the investigation of those biting flies of whose habits little or nothing has been hitherto known in India. With a view to obtain materials for this enquiry, sets of apparatus and copies of the bulletin on biting flies, have been issued to persons and associations likely to render help. In this connection Mr. Howlett is in complete touch with special officers of the medical and veterinary departments. He arranged in February 1909 an exhibition of all kinds of blood-sucking and parasitic insects for the pathological section of the Bombay Medical Congress, and read a paper on the habits of sand-flies. He has ascertained the life-histories of nearly all the mosquitos which occur in Pusa and has found two species of fish which are capable of destroying large numbers of anopheles larvæ. A report on the natural enemies of mosquitos was furnished to the Director of Agriculture, Bengal.

A comprehensive investigation of the several species of fruit-flies which attack mangoes, peaches, etc., is in progress. The life-histories of several of these have been worked out, and methods of destroying the mango fly have been tested with success. An attempt to check the annual attack of these pests on the peaches grown at Pusa, was so far successful this year that the period of severity was postponed; thus the Imperial Economic Botanist was able to complete certain experiments.

Mr. Froggatt, Entomologist to the Government of New South Wales, visited Pusa in June 1908 to obtain information regarding the fruit-flies in India, the Australian fruit-flies being related to those found in India. Specimens have, therefore, been supplied to him.

Arrangements have also been made with Professor Silvestri to supply parasites of some of the south Indian species in the hope that they may be utilized against the olive fruit-fly, a species which inflicts great damage in Italy.

Specimens have been lent to the Indian Museum, Calcutta, in connection with the revision of nomenclature of various groups of Indian diptera. A large representative collection of tabanidæ has also been lent to the British Museum to assist in like manner the revision of that family now in progress.

Mr. Howlett contributed to *Indian Insect Life* the portions relating to diptera and sections on mallaphaga, anoplura and cimicidæ.

A memoir on sand-flies is under preparation in collaboration with Dr. Annandale of the Indian Museum.

Mr. Howlett controls the work of the artists at Pusa and is endeavouring to raise the standard of illustration work which is a most valuable part of the publications of the Imperial department.

12. *Cotton*—Cotton continued to receive a great deal of attention from the agricultural departments. Mr. G. A. Gammie, who has done much useful work in cotton, was appointed Imperial Cotton Specialist in December 1907. His report is separately published with those of the heads of sections at Pusa. It is unnecessary to minutely review it. The co-ordination of the experiments that are being conducted on this crop, will now be possible, and Mr. Gammie's advice in the improvement of cotton ought to prove of great help to the agricultural departments. The principal lines of improvement attempted have been (*a*) selection and distribution of cotton seed, (*b*) introduction of superior indigenous varieties and better methods of cultivation, (*c*) hybridization, and (*d*) trial of exotic varieties.

(*a*) Selection and Distribution of Seed.—The distribution of seed of selected picking from cultivators' fields

has been in progress for more than four years in several provinces, but without any marked result. This is hardly surprising, for such selection, while no doubt supplying sound seed, is, properly speaking, no selection at all, since the fields ordinarily contain many varieties mixed together. It is by separating types, and continued plant-to-plant selection that real improvement can be effected. This line of work is now being followed on Government experimental stations with very encouraging results. On the Surat farm, the different types found mixed in Khandesh cotton, have been isolated and have been sown separately to determine the comparative value of each. Similar experiments are in progress in Madras. At Akola in the Central Provinces promising work is in progress in the separate cultivation of the four distinct varieties of cotton which are now grown mixed by the *ryots* under the names of *jari* and *kati vilayati*. Of these the *malvensis* seems to be a distinctly superior variety, and special attention is being directed towards selection from it.

Eight cotton seed farms were worked by private agencies in the Central Provinces in 1908 under the guarantee of the department against loss. Such farms have been in existence for the last four years. They grow the ordinary *jari* and *bani* varieties of cotton, and are situated in districts which have special reputation for the high quality of their cotton. The seed of first and second pickings is purchased by the department at more than market rates for distribution. In course of time when the selection now going on at the experimental stations has borne fruit, these farms will become useful agencies for the distribution of improved strains of seed. The ultimate object is to establish a number of such farms independent of the department, but receiving, when required, assistance in the provision of seed, trained staff or advice. In the Punjab, Bengal and United Provinces selection of cotton seed is in progress.

(*b*) Introduction of Superior Indigenous Varieties and Better Methods of Cultivation—There has been a marked extension of this line of work, specially in Bombay and Madras. The introduction of Broach cotton into the

Dharwar district has been attended with considerable success. This cotton is superior to the locally grown *kumpta* variety not only in quality, but also apparently in average yield per acre and in lint percentage. In 1908, sixteen thousand pounds seed of Broach cotton from Navsari were sown in these parts, in addition to some of the seed of this crop grown locally in 1907. Steps are being taken to get the people to cultivate it properly and to adopt a cleaner system of picking. Some efforts were made to introduce Broach cotton under irrigation in the Deccan, but owing to faulty cultivation and irrigation on the part of the cultivators, the experiments were not successful. Attempts have been made to improve the quality of Broach cotton in northern Gujarat by introducing seed of the superior Navsari variety from the south of the district. In the Tinnevelly district of Madras the *karungani* variety has been found to be superior in quality and yield to the *uppam* variety. Arrangements were, therefore, made by the department to sell pure *karungani* seed sufficient to sow about 8,000 acres in 1908. This work was partly helped by the grant from the British Cotton Growing Association. The Madras Agricultural Department has also made successful efforts to improve the *ryots'* methods of cotton cultivation. Expert cultivators are sent to teach the use of the country drill and bullock-hoe, and to demonstrate the value of improved cultivation. Implements are supplied free of cost, and expert labourers are sent to help the growers. The advantages of the drill are becoming widely appreciated, and in all, 1,000 acres of private land were sown with the drill last year, and many *ryots* have learned to use the drill.

(*c*) HYBRIDIZATION.—Experiments in hybridization were continued at several centres. They have brought to light some new ideas which, however, require confirmation. The crosses at the Surat farm have been found to be undergoing considerable variation. Although their lints have a relative advantage in quality over the ordinary Surat cotton, the ginning percentage is steadily falling. (The percentage has fallen from 36·9 to 30·3 during the last five years.)

The crosses have not yet been grown on a sufficiently large scale to properly test the outturn per acre. The lints of 21 hybrids grown on the Surat station were valued from 5 to 10 per cent. above fine Broach. At Dharwar some encouraging results have been obtained by crossing *inter se* newly introduced varieties from America and Egypt. Work on similar lines is being done in the Central Provinces and Madras, but until the hybrids show greater stability, it is impossible to estimate their value.

(*d*) TRIALS OF EXOTIC VARIETIES.—Trials of exotic varieties on Government farms and in cultivators' fields were continued. It is disappointing to have to record a set-back in the expectations previously formed regarding Egyptian cotton in Sind. Up to 1907, the area under this cotton was increasing, but last year owing to the short supply of water, till long after the proper sowing season, the area decreased, and the quantity as well as the quality of the produce much deteriorated. Further, on account of faulty methods of cultivation, careless picking and admixture of leaves and dirt, the produce was so inferior that great difficulty was experienced in disposing of it. There were no bidders at the three auctions held in November, December and January last. The cotton had ultimately to be sold to a Bombay firm who wanted it for a particular trade purpose and paid only Rs. 9 per maund for *abassi* and Rs. 8-6-0 for *metafifi* as against a minimum of Rs. 11 per maund secured in the previous year.

The average outturn per acre of Egyptian cotton in Sind has been, during the last four years, much lower than that of the hardier indigenous variety, and much less than was originally expected. This is mainly due to bad cultivation on the part of the *ryots* who do not follow the instructions of the department. Unless cultivation is improved, and sufficient flow irrigation is obtained as early as March—April, there is no likelihood of Egyptian cotton being established as a general field crop in Sind. The Government of Bombay are taking steps to secure these conditions. It is disappointing, however, to record that this year (1909) no sowings in Sind of Egyptian cotton have been made on account of the difficulties of water-supply.

Some promising results have been obtained from the trials of American and Cambodia cottons in parts of the southern Maratha country.

The area sown with American cotton in the Jhelum colony of the Punjab increased in 1907, but on account of the scarcity of labour due to the epidemic of plague, the area was restricted last year. There has been, however, no large decrease in the number of cultivators growing this cotton. Arrangements were made last winter to dispose of the produce by auction as is done with Sind grown Egyptian cotton, and the results were most satisfactory, the cultivators obtaining an adequate price for their produce. The trials with Egyptian cotton in the Punjab have not yielded any satisfactory results. The Economic Botanist has now imported a new variety which he considers better suited to the Punjab.

Acclimatised American cotton was successfully grown in 1907 by many cultivators in the Aligarh district of the United Provinces, and there was a large increase in the demand for seed for the next year's crop. It is anticipated that the quantity of this cotton will soon be sufficient for putting it on the market on a commercial scale, and the prices offered will determine whether it will be permanently established in these provinces.

In the Central Provinces and Bengal, *burhi* cotton (an acclimatized variety of American type) has continued to give successful results. Efforts are being made to extend the area under this cotton and to improve the quality and outturn by selection. In the Central Provinces arrangements were made during 1908-09 to secure a large supply of seed for distribution. It is a good cropper in districts of fairly heavy rainfall, yields a high percentage of lint of good quality and is comparatively immune to wilt.

In Madras and Burma, experiments with Egyptian and other varieties of cotton are in progress.

13. *Tree Cottons*—Further trials with tree cottons have confirmed the opinion which I have previously expressed, *viz.*, that they will never enter into regular cultivation in

India. The experiments made by Messrs. Shaw, Wallace & Co. with this class of cotton, have generally failed. The chief centre of their operations was the Mourbhanj farm. One hundred and seventy acres were planted out with perennial cottons in 1907. In the succeeding year this area was increased to about 300 acres. In August 1908 the plantations were inspected by me in company with the Director of Agriculture, Bengal, and a report was submitted to Government. The experiments having failed have been abandoned since March 1909.

Some success has been obtained with the Bourbon variety in the Bombay Presidency, and favourable results have been obtained here and there in Assam and Burma, but the place of tree cottons as a field crop in Indian agriculture is very limited.

14. *Wheat*—Mr. Howard has completed his classification of Punjab wheats and has isolated some 25 types, the best of which (after a few years' multiplication) will be available for distribution with accurate information as to the several qualities for which they are valuable. This line of investigation as far as the Punjab is concerned, has been taken over by the officers of the Agricultural Department of the province, and a large number of pure types were grown on fairly large comparative plots on the Lyallpur farm this year. They afforded a magnificent object lesson in what can be done by systematic selection. Many of the varieties yielded over 30 maunds of grain per acre. Large numbers of colonists came to see the comparative plots and arranged for small supplies of seed for trial on their own holdings. In the Punjab the best varieties of wheat as classified agriculturally, will be submitted to milling and baking tests. The preliminary tests made last year by Mr. Humphries for Mr. Howard, have established the important point that wheats which are well suited to the Punjab, are not lacking in strength, and that for many years there has been a mistaken impression regarding the kinds of wheat which should command the best prices for export. Mr. Howard's conclusions have been brought to the notice of various influential commercial bodies. If fully substan-

tiated they may effect a material alteration in the export wheat trade, inasmuch as the cultivation and export of the stronger wheats with hardy characters may be advantageous to the agricultural and commercial interests of India. The survey of the Central Provinces and Bengal varieties of wheat is fairly complete, and that of Bombay, United Provinces and Burma is in progress. In the Central Provinces Mr. Evans grew selected varieties on fairly large areas for distribution. He has now taken up the question of their milling properties and value for export. Rust-resistance experiments are in progress in several provinces, but no very definite results have yet been obtained. Muzaffernagar wheat continued to give encouraging results in Bengal; Buzar wheat was also successfully grown in certain parts of the province. The Burma Department of Agriculture issued a leaflet on wheat cultivation in English and in several of the vernaculars of the province. Attempts to profitably grow wheat on ordinary lower Burma lands have, however, hitherto proved unsuccessful owing to the unsuitability of the soil, temperature and moisture. Earcockle in wheat (*Tylenchue scandens*) was reported from 12 of the districts in the Punjab, and steps were taken to check it. A bulletin on "the Milling and Baking Properties of Indian Wheats" has been published by Mr. Howard, for which there was a good demand from those interested in the wheat trade.

15. *Groundnut*—There has been a large increase in the area under this crop due to the efforts of the agricultural departments to introduce it into new districts. Experiments on the Poona farm to check the *tikka* disease by steeping the seed in copper sulphate and by spraying with Bordeaux mixture, have so far not given any encouraging results. No improvement in the treated plots was visible, and an increase in the yield obtained in the first year was not maintained in the following years. This is because the fungus forms quantities of spores on the lower surface of the leaves which are not reached by a spray, however carefully applied. As it is possible that seed from diseased plants may convey the disease, it is advisable to steep all seed before sowing. The seed should not be removed from

the husk until a day or two before sowing. It is possible that spores adhering to the husk may spread the disease; therefore the seed in husk should be steeped. This is specially necessary when seed is sent to a new locality. The early maturing varieties have been found to suffer the least, because before their leaves are severely affected, the nuts are fully set. The agricultural departments are, therefore, trying to obtain an early ripening variety by selection and hybridization. The Bombay Department of Agriculture has, for some years past, been distributing seed of different early maturing foreign varieties of this crop. The new varieties have now practically ousted the old ones in the Satara district and are considered by the people to be superior. The Bombay and Central Provinces departments are investigating the value of growing groundnut as a mixed crop with cotton, *jowari*, etc. In the Bombay Presidency very variable results have been obtained as to percentage of oil in both foreign and indigenous groundnuts grown under different conditions. The causes which determine this variability are being worked out as far as possible.

The Palur farm in Madras has been established chiefly to study the groundnut crop. Exotic and other varieties are being tested there, also the rotations and methods of agriculture most suitable. The experiments at Palur have proved that the dead ripe leaves and stalks of groundnut are a cheap and effective manure for paddy. Efforts are being made to spread the cultivation of groundnut by means of demonstration plots in districts where the cultivation is at present trivial. Groundnut as a rainfed crop is rapidly spreading on the West Coast of Madras, where it was unknown before, and where a new and profitable crop for the dry lands is a decided want. The Local Government have given a grant to encourage the introduction of groundnut in south Canara. The rapid spread of this crop to new districts where the cultivation is not understood, has given increased importance to this subject in this Presidency.

In Bengal, the crop seems to have a considerable future before it, specially in Orissa where the experiments during the last two seasons, have yielded some valuable result.

The trials were made on poor sandy soil unsuitable for most other crops, and the yield obtained was very satisfactory. The crop thrives on sandy soil, but requires liberal dressings of manure.

In Eastern Bengal and Assam groundnut was tried in 1908 and gave good results on all the farms. The experiments are to be repeated this year on a commercial scale. No sign of disease appeared anywhere in the province last year with the doubtful exception of Rangpur.

In the dry zone of Burma the cultivation of this crop has gone up by leaps and bounds; the area last year was about 250,000 acres. The crop is a boon to the dry zone, as it affords relief to the inhabitants of this oft scarcity-stricken area. The extension of cultivation has been entirely due to the action of the department in beginning the distribution of sound seed of good varieties some few years ago. A scheme for the establishment of seed depôts for extensive distribution of selected seed of the best varieties is under consideration.

16. *Sugarcane*—Sugarcane is extensively grown in many parts of India. Efforts are, therefore, being made by the agricultural departments to improve its cultivation, and the processes of extracting juice and of sugar manufacture. The Madras Department of Agriculture has a large experimental station at Samalkota where special attention is being paid to this crop. The Mauritius sugarcanes introduced at Samalkota have largely ousted the local canes in the Godavery delta. The distribution of canes from this farm has been so extensive that *ryots* are now able to obtain seed canes of good varieties from each other. There was a severe outbreak of disease on the farm in 1907. It was probably due to the shortening of the period of rotation which will now be rectified. Among new varieties the Barbados seedlings B. 208 gave a very good analysis. The introduction of red Mauritius canes in south Arcot seems to be very promising. The cane when crushed gave very good results in percentage of jaggery to juice and percentage of cane sugar. There is a good field for the introduction of sugarcane in Tanjore and Malabar where

experimental cultivation has proved that the climatic and other conditions are quite favourable.

Among manures farm-yard manure and castor cake have, as before, given the best results. At Samalkota, an addition of bone dust to castor cake has given an increased outturn. At Manjri, the Bombay sugarcane station, a top dressing of sulphate of ammonia used respectively with farm-yard manure and cake, gave large net profits. This fact is of special interest, in that sulphate of ammonia is likely to be manufactured on a large scale in this country before long. At Manjri some of the manures are believed to have produced a marked effect on the quality of *gur*. Further experiments are, however, necessary to confirm this point. Other problems connected with methods of cultivation, selection and amount of water required, continue to receive attention.

Satisfactory progress has been achieved in the improvement of the methods of manufacturing crude sugar. Iron mills are now in very general use in most provinces. A primitive, but very economical, method of making *gur* is in common practice in Burma. The Director of Agriculture, Burma, has promised to give me an illustrated article on the subject for the *Agricultural Journal of India*.

The trials with a power cane crusher during the year 1907-08 at Manjri, seem to indicate that its work is somewhat cheaper and more efficient than the iron roller mills worked by bullocks. It is proposed to continue the experiments with a larger pattern of power mill, and to bring the advantages to the notice of cultivators.

Useful work on an extensive scale was done in the United Provinces in demonstrating Mr. Hadi's process of sugar manufacture. Men from other provinces have been trained in the process. Trials in other provinces have been made. This process, however, when worked on a small scale in Bombay and the Punjab, has not been found to be so profitable as the native methods of *gur* making. This is due to the dearness of labour and the high prices which *gur* as such commands in various parts of India, owing to its suitability for Indian sweets and cookery.

17. *Tobacco*—Experiments in the cultivation and curing of tobacco which are in progress in Bengal, Madras and in parts of Bombay Presidency, have yielded some encouraging results. Among foreign varieties, Zimmer's Spanish has been found to give the best results at Pusa and Dalsing Serai, Tirhoot, both in point of quality and quantity. It is a plant which appears in every way suited to the soil and climate of Behar, and possibly to other parts of India. The variety is very much appreciated by the cultivators in Behar. Much work, however, remains to be done with regard to the indigenous varieties. Locally grown manufactured tobacco would probably take the place of imported tobacco, if proper methods of cultivation and curing were practised. But the many difficult problems connected with cultivation and curing yet remain to be solved. The Eastern Bengal and Assam Department has undertaken the study of these problems at Rangpur. The scheme of experiments proposed for this farm is based on enquiries made in the tobacco growing districts of Eastern Bengal and Assam. The results are, therefore, likely to be of substantial benefit to the *ryots*. A new curing house has been erected at Nadiad in northern Gujarat from funds given by the Inspector-General of Agriculture in India, and was used for the first time last year. The leaf cured in the new barn was sent for valuation to the Star Tobacco Co. of Bombay who declared it suitable for the purposes now served by imported leaf. The best sample was valued at 5 annas per lb., when the value of country cured tobacco was 1 to $1\frac{1}{2}$ annas. The advantages of deep ploughing for tobacco have been fully demonstrated at this station. Manurial experiments have shown that castor cake (600 lbs.) with farm-yard manure at the rate of 10 tons per acre, gives a substantial net profit. This fact is of special interest in northern Gujarat, because castor cake is largely manufactured at the Sabarmati mills near Ahmedabad. The effect of these manures was considerably enhanced by deep cultivation. In Burma, arrangements have been made to experiment with American varieties and to introduce new methods in the experiments. In Madras, Messrs. Spencer and Co. of Dindigul, are continuing experiments to

determine whether good wrapper leaf can be obtained from Indian grown tobacco. Dr. Butler and Mr. Lefroy have made progress in investigations regarding the fungoid and insect pests which affect this crop. Mr. Howard hopes soon to complete the botanical survey of Indian tobaccos.

18. *Indigo*—The scientific investigations at the indigo research station, Sirsiah, continued to be controlled by Mr. C. J. Bergtheil till March 31st, 1909, when he reverted to his post of Imperial Bacteriologist at Pusa, on the termination of his deputation under the Government of Bengal. Meanwhile the Behar Planters' Association applied for the renewal of the grant. The Bengal Government have promised an annual subsidy of Rs. 32,000 for five years from 1909, on condition that the planters should contribute the balance of Rs. 10,000 for the continuation of the work at Sirsiah. Mr. Bergtheil resigned the Indian Agricultural Service on the 28th June 1909 to take up service under the Behar Planters' Association. A committee was appointed in October 1908 to consider and report how far the research work at Sirsiah is affected by Mr. W. P. Bloxam's report on his work at Leeds published in England. The report of the committee has shown that continuation of research work in indigo is absolutely necessary. The question of further improvement in the process of manufacture is still undecided, and can only be settled by very definite investigations. Little has been done in the improvement of the indigo plant by selection for indican leaf content per unit of land. The effects of soil, manures, tillage, season, etc., have to be further studied. These investigations require the services of a bacteriologist, a chemist, an economic botanist and an agriculturist. They are not likely to be complete in less than five years. As the result of Mr. Bergtheil's work on the fermentation of indigo and the determination of the best conditions of steeping, the planter is now enabled to prolong his period of manufacture and to control it under variable climatic conditions. The methods of pruning the Java plant to promote formation of leaf and prevent flowering, have proved of value, as they result in as many as three cuttings being

obtained in a season. The practice of light loading with Java plant of good quality, renders the process of extraction more efficient than the heavier loading previously employed by the planters. The Java plant is now established over a very large proportion of the total indigo cultivation of Behar. With this variety the output of indigo per acre has been doubled without extra expense to the planters. The sulphuric acid treatment of Java seed has now definitely showed its superiority over mechanical scarification for overcoming the difficulty of germination, and has been extensively adopted by the planters. It is believed that the industry in natural indigo will successfully compete with that of the artificial product, if more reliance is placed on the improvement of seed and of methods of cultivation than upon improved methods of manufacture. Little more than a commencement has yet been made in seed selection of either the Java or Sumatrana variety. There is great scope for improvement in this direction : (A) in obtaining a disease resisting plant, and (B) in improving the dyeing content of the leaf. A brief summary of the work done by Mr. Bergtheil at the Sirsiah research station is published as Appendix B to this report.

19. *Jute*—At present the cultivation of jute is practically confined to Bengal and Eastern Bengal and Assam. In both these provinces, it is one of the most important crops, and its cultivation has increased rapidly, owing to high prices during recent years. In 1907, the area under this crop in these provinces was the largest on record, but there was an estimated decrease by 28 per cent. in the area sown in 1908. The outturn was probably largely under-estimated, as there was a large drop in prices. The cultivation of jute is extending in Assam and is very profitable. As the cultivation of jute does not prevent the raising of paddy or a *rabi* food crop on the same field in the same year, such an extension is not likely to menace food supplies. The cultivation of this crop rapidly increased in Behar for two or three years, but has as rapidly declined. Jute grows well in parts of Orissa in rotation with paddy or potatoes, and a series of experiments on this crop have been commenced at the Cuttack

agricultural station. Experiments have shown that this crop may possibly be successfully grown with irrigation in the Chhattisgarh and Nagpur divisions in the Central Provinces. The yield at Nagpur last year was at the rate of $18\frac{3}{4}$ maunds per acre, and the fibre was valued at Rs. 6 per maund. The crop will continue to be grown on demonstration plots in the Central Provinces, but its cultivation will, probably under rotation, be limited to tank irrigated areas where it may possibly alternate with wheat. In the Madras Presidency a number of private land-owners are trying jute in small areas on the Malabar coast districts. The continued high price of rice coupled with the fall in the price of jute, has made the prospect of introducing jute there less promising. The experiments in Tanjore were unsatisfactory, and only a few plots on the West Coast did well. This work will be held in abeyance, till an agricultural station can be opened where the cultivation can be properly studied. Jute in the Ganeshkhind gardens, Poona, yielded for the first time a clear profit. The possibility of its extended cultivation in Bombay Presidency is, however, remote for want of facilities for irrigating the crop at its early stage. At Lyallpur in the Chenab colony an average yield of 11 maunds of fibre per acre was obtained, but the profitable cultivation of jute in the irrigated districts of the Punjab, is not likely, unless practical arrangements can be made for retting the crop. Tanks filled from the canals would probably usually be required. The experimental cultivation of jute in Burma has been limited to jail compounds. In that province the lack of sufficient labour is likely to be a serious difficulty in the way of extended cultivation.

Definite results have been obtained from the series of experiments commenced at the Burdwan experimental station in 1904 and carried down to date. The experiments were directed to ascertain the best and most economical manure, time of cutting, the most profitable variety and such other practical points. These results have been published in leaflet no. I of 1908 of the Agricultural Department of Bengal.

Mr. Finlow has undertaken in collaboration with the Reporter on Economic Products to the Government of India, an extensive study of the races of jute in Bengal and Eastern Bengal and Assam. The effects of soil, climate and of the retting water on the quality of fibre produced, are being studied. Mr. Finlow has also undertaken cross fertilization experiments with various races of this crop. He collaborated with Messrs. Cross and Bevan of London in an investigation into the causes and possible means of prevention of the deterioration of jute fibre technically known as "Heart Damage." Messrs. Cross and Bevan have presented a report to the India Office based on the results of their examination of a number of bales of jute especially treated in India by the Agricultural Department of Eastern Bengal and Assam before export to London. The report does not help the trade in any way, as the recommendations made therein are not practical. Meanwhile in the experiments conducted by Mr. Finlow at Pusa, "Heart Damage" has been produced under well-defined conditions, and it is hoped that definite results will be obtained in the near future from the work in India.

20. *Flax*—Flax as a fibre crop is not yet produced on a commercial scale in India. There are large areas under linseed in the different provinces, and it is possible that the fibre crop might supplant the seed crop in some places, but certainly not in the black soil districts where the seed crop is grown profitably with light *rabi* rainfall. The stems of the seed crop might, however, be utilized for fibre, but experiments are required to determine this, and also to show how such fibre can best be utilized. Flax experiments in Behar have made considerable progress. During the cold weather of 1907, flax was sown on an area of over 100 acres at Dooriah under the supervision of Mr. Vanderkerkhove, a practical flax farmer from Belgium, who is employed by the Government of Bengal. Mr. Vanderkerkhove gave advice on the experimental cultivation of this crop at Pusa. The results obtained are very satisfactory, the straw produced being far better both in quantity and quality than in the previous year. The

experiments indicate that in an ordinary season in Behar, flax is likely to yield a profit which is estimated at over Rs. 74 per acre. Mr. Vanderkerkhove has issued a report, an extensive illustrated summary of which has appeared in the *Agricultural Journal of India*, volume III, part 2. He has been engaged for a term of five years in order that he may assist in the thorough working out of such questions as the comparison of indigenous and exotic varieties of flax, the selection of proper lands, manures, rotations and retting methods. The experimental cultivation of flax last season at Dacca and in Cachar, produced sufficiently good results for extended trials, which are arranged for in Assam, this year. Other conditions being equal, the absence of lime in the retting water would probably enable Assam to produce a higher grade of fibre than Behar. An illustrated bulletin dealing specially with the prospects of flax in Eastern Bengal and Assam, will be shortly issued. Except on the Dharwar farm, the different varieties of imported flax have not yet been found suitable for cultivation in the Bombay Presidency. It is believed that varieties of linseed which are suitable for fibre would grow well in the Punjab. There is an extensive cultivation of linseed for purposes of seed in the Punjab, especially in the Kangra district. This variety may not be suitable for fibre purposes owing to its established habit of bushy growth. It is thought that good fibre has been obtained from trials made with Russian flax, but the retting difficulty is considerable. This is being studied at Lyallpur.

The machinery required for breaking, scutching, etc., is simple and inexpensive. The work is very well done at Dooriah by ordinary coolies trained by Mr. Vanderkerkhove.

21. *Other Fibres*—Other important fibre crops are *Hibiscus cannabinus* (Bombay hemp), *Crotalaria juncea* (*sann*-hemp), agave and rhea. *Hibiscus cannabinus* is cultivated in many parts of India as a mixed crop, but rarely as a pure crop. Its cultivation can only be recommended in districts of moderate rainfall. In Madras, its cultivation is established in Vizagapatam and Guntur and is likely to expand. In Bombay Presidency, this crop is remunerative, chiefly because the fibre is used for ropes and

other home purposes. The fibre of *sann*-hemp (*Crotalaria juncea*) does not compete with jute as does that of *Hibiscus cannabinus*, but in market value it is superior to both. *Sann*-hemp can best be grown in districts of moderate rainfall and, therefore, does not compete with rice. It is in some parts of India frequently grown as a green manure crop before rice, and as a second crop in the same year after rice for fibre; and this rotation is advantageous because it is a leguminous crop. As a green manure crop, its value is well known in some provinces, but as a fibre crop its cultivation is somewhat restricted. In the Central Provinces, it is always grown as a pure crop and is cultivated for its fibre chiefly. The area under *sann*-hemp has nearly been doubled during the last ten years in the Central Provinces. This crop is a well-recognised feature of the agriculture of the United Provinces, and the trade in fibre is an organised one. The conditions of the soil and climate suitable for agave and rhea are now fairly definitely known. It is now known that both agave and rhea require good land, and that for the latter crop also fairly heavy rainfall is required. Although it is possible to extract both agave and rhea fibre by hand, the products thus obtained are inferior to those obtained by machinery. Therefore, possibly, the cultivation of these plants should, for some time, be continued by capitalists who can afford money for extracting the fibre by machinery. Both agave and rhea require two or three years' growth before they give any particular return in fibre, a fact which discourages the ordinary *ryot* from attempting their cultivation. A general investigation of fibre-yielding plants has been commenced, and is being carried out not only with regard to the intrinsic value of the fibre, but with reference also to the agricultural possibilities of the plant in question, an equally important point. Rather full information on the subject of fibre crops is being published in pamphlet form. It is now in the press.

22. *Tea*—The Indian Tea Association continued to receive the annual subsidy of Rs. 15,000 from the Imperial Government and of Rs. 13,500 from the Governments of Bengal and Eastern Bengal and Assam. At the Heeleaka

experiment station maintained by the Association, manurial tests were made to find the most economical manures for renovating the tea soils and for improving the quality and the yield of tea. They showed that oilcake is the most economical manure for renovating old tea bushes on light soils. Mineral manures, such as superphosphate, sulphate of potash and nitrate of soda, have been found to be equally effective, but more costly. The application of nitrogenous manures, such as nitrate of soda and sulphate of ammonia, produced better effect when used in conjunction with superphosphate and potash.

The relative merits of several green-manure crops were tested for three years. *Dhaincha* (*Sesbania aculeata*) was found to grow vigorously and also to increase the yield of leaf in tea. *Arhar* (*Cajanus indicus*) produced a large amount of organic matter and improved the texture of the soil, the condition of the bushes and the growth of new wood. The special value of cattle manure on light soils is being tested. The experiments to test the manurial value of bones, have so far not yielded any definite results.

Different methods of pruning have been under trial. Progress was made in investigating the diseases of the tea plant, such as the Tread Blight, the Grey Blight and the Copper Blight.

The Imperial Entomologist investigated thrips in tea in the Darjeeling district. The loss was estimated at about a half to one maund of tea per acre on the affected blocks. Spraying with various contact poisons was tried; such insecticides as soap, oil emulsions and rosin compounds, proved effective at proper strength. Of all these the rosin compound is the cheapest, it 'wets' well, drys rapidly forming a varnish of rosin over the bud or leaf, and penetrates extremely well into a curled-up leaf. It does not affect the flavour, even when sprayed leaves are plucked and manufactured within one week after spraying. It prevents a loss of Rs. 40 to Rs. 60 at a cost of Rs. 3 per acre. A note on this subject will be published in the *Agricultural Journal of India*, volume IV, part III.

23. *Cassava*—Cassava is cultivated in most of the provinces of India. It is a drought-resisting plant requiring

only about 14 to 16 inches of rainfall, and is thus of great potential utility in districts liable to attacks of famine. Experiments on a small scale have been continued on various Government stations since 1902, chiefly to ascertain whether its cultivation could be more widely extended. These experiments included comparative trials with the best varieties, both indigenous and imported, to determine the most suitable variety as regards (*a*) outturn, (*b*) yield of starch, and (*c*) drought-resisting qualities. The experiments on the Poona and Manjri farms in the Bombay Presidency were quite successful and are being extended to other districts in the Presidency. The plant has been found to thrive anywhere in India up to an elevation of 4,000 feet or so. The cultivation requires very little trouble. The average outturn of tubers per acre on the Manjri farm was 16,248 lbs. The percentage of starch to whole tubers varied from 16 to 25. The tubers sometimes contain a poisonous principle which is, however, dissipated by roasting or boiling. The chemistry of the tubers was studied by the Imperial Agricultural Chemist, and an account of his investigations appeared at page 64 of the annual report of the Imperial Department of Agriculture for 1904-05.

The most economic method in a small industrial way of preparing tapioca starch is to wash the tubers well as soon as they are lifted, and then to immerse them in cold water for a night. The dark coloured rind is then peeled off with a sharp knife. The peeled tubers are cut into small pieces, washed and crushed into a pulp which is then put in a cloth bag, and after subjection to pressure to force out any poisonous juice, is washed, sifted and dried. A sample of starch prepared in this way at the Poona farm was examined by Dr. Leather, and no trace of prussic acid was found in it.

Cassava starch commands a ready sale among the Bhils of Khandesh and Punchmahal districts of the Bombay Presidency, and the department is making efforts to extend the cultivation of the crop in these and other districts by distributing free sets.

The Salvation Army also are making successful efforts to introduce cassava in its sun-dried and flour (*Mookti*

Fouz ka atta) forms in many places. They have also made arrangements for planting the crop on their colony farms near Ahmedabad in Gujarat and also at Ahmednagar, Bareilly and other places. The Imperial Department of Agriculture supplied during 1907-08 and 1908-09 the Salvation Army and many other applicants with numerous cuttings of both introduced and Indian varieties.

24. *Artificial Fertilizers*—Throughout the greater part of India there is little demand at present for phosphatic manures such as bones, mineral phosphates or superphosphates. European planters interested in tea, coffee, indigo, sugarcane, tobacco, pepper and such special crops, use in a small way mineral fertilizers including phosphatic manures. Oil-cakes are in much greater request by European planters and by native agriculturists. These are obtained throughout the plains of India in great variety, in large quantities, and ordinarily at very cheap rates. They are the artificial manures of India and are extremely effective, especially for the most valuable irrigated crops. Experiments on Government farms have shown that ground bones and ground mineral phosphates act extremely slowly when applied to ordinary field and garden crops. Dissolved bones and superphosphates are much more effective, but their cost is prohibitive, as sulphuric acid has to be imported, and freight charges are excessively high. As soon as sulphuric acid is made in India, mineral phosphates will be largely utilized as superphosphates, particularly in certain parts of Bengal, especially in Behar, where over large tracts the soil is known to be exceedingly deficient in phosphoric acid. Nitrogenous manures seem to do well on black cotton soil. A series of experiments with nitrate of soda and sulphate of ammonia, have given very good results in the Central Provinces. Nitrate of soda seems to have the effect of reducing the attacks of stem borers on some crops, more particularly cotton. Repeated trials with saltpetre in the Central Provinces have conclusively proved that it is a profitable fertilizer for cereals, even for dry crop wheat, if in the *rabi* season there is sufficient moisture in the soil to dissolve it. The application of concentrated manures to crops under irrigation, seems to offer better chances of

success than in the case of crops that depend on rainfall. A small top-dressing of nitrate of soda applied to wheat in Sind gave a distinct profit. In the case of sugarcane a top-dressing of sulphate of ammonia produced at Manjri and at Chalisgaon better results than any other artificial manures and gave large net profits. The use of castor cake as a fertilizer for sugarcane and vegetables, has been gradually extending in the Punjab. In the Madras Presidency, *pattimannu* (manurial earth) is largely used by *ryots* to maintain the fertility of wet paddy lands in the Krishna delta. But this earth is practically unobtainable in some parts of the delta, and the agricultural department is trying to find out by experiments a cheap and effective substitute for it. Encouraging results were obtained in 1908 from experiments with some artificial manures in comparison with *pattimannu;* therefore the department is extending the trials and demonstrating to the *ryots* the advantages of substitutes. As calcium nitrate is likely to be manufactured in Kashmir, this manure and also calcium cyanamide were tried in various provinces to ascertain their utility for Indian agriculture. The manures were tried on wheat and linseed in 1907. The results were not very encouraging. There was a slight increase in outturn due to the application of calcium nitrate, but this increase was not in any case sufficient to leave a margin of profit. In the Central Provinces and Bengal the department of agriculture sells to cultivators artificial manures from the departmental stock which is tested by the Agricultural Chemist. The object aimed at is to protect the few cultivators who can use these manures from false dealing. Much useful work has been done by the Agricultural Chemist of Mysore in analysing the composition of the various fertilizers stocked by dealers in this country.

25. *Distribution of Seeds*—This branch of work has increased in importance. There was such an increased demand for pure and improved seed in some of the provinces that the department found it difficult to exercise proper supervision over the distribution. Agricultural associations, shows and field demonstrations have greatly helped in popularizing the use of improved seed. Seed

depôts have been established in Bengal, Eastern Bengal and Assam and the United Provinces, where seed of the best varieties of the crops generally grown in the provinces is stocked. These depôts also supply seed of crops, the cultivation of which is likely to be introduced with advantage. No seed is issued without careful selection by the officers of the departments. The seed is obtained from crops grown on Government farms, or is specially selected from the crops grown by *ryots* on their own fields. In other provinces seed farms have been opened for growing and distributing seed of such varieties of crops as have been found most suitable for the localities in which the farms are situated. When the seed of a crop new to a locality is distributed, leaflets are usually issued giving instructions as to the best methods of cultivation. Wherever possible the departments have supervised such cultivation and have given advice from time to time.

It is proposed to establish a seed-testing station at Poona, Bombay Presidency, to ascertain the purity and germinating capacity of seed available in this country.

The Bombay Department distributed during the last two years about two thousand maunds of seed, principally that of cotton. A marked development was made during the year in the distribution of cotton seed in the United Provinces, Madras and the Central Provinces, with the help of the grant made by the British Cotton Growing Association. It is proposed to organise in the United Provinces co-operative seed societies as soon as a fair start can be made. In Bengal the fine *aus* paddy of the Central Provinces is gaining favour with the cultivators, as it is likely to do well in many parts of the province, provided the rains are seasonable. In Eastern Bengal and Assam, Naini Tal and Patna varieties of potatoes grown after jute, have given excellent results. Large quantities of seed of these varieties were, therefore, distributed with instructions as to their cultivation. The crops were found to be diseased in some places, but the department demonstrated the value of spraying with Bordeaux mixture which has been found to be very efficacious.

The office of the Inspector-General of Agriculture in India continued to receive numerous indents from foreign countries for seeds, and the provincial Directors have kindly helped as usual in meeting these demands. A total quantity of nearly $4\frac{1}{2}$ tons of seed in small parcels was sent abroad during the period under report.

26. *Distribution of Implements*—Satisfactory progress has been made in the transference of superior indigenous implements from province to province and district to district. The agricultural exhibitions and shows which are being organised all over India, are doing useful work in this direction. It is always a problem of considerable difficulty to get improved foreign implements of undoubted value adapted to the requirements of the cultivators. In addition to the question of initial cost, instructions for their use and arrangements for repairs have to be provided. The United Provinces have attempted to meet these difficulties by village agencies. These institutions are managed by local agents with whom implements are placed and from whom they can be hired or bought. An agricultural assistant visits these agencies from time to time accompanied by a *mistri* who can repair the implements. The assistant also visits the cultivators who have adopted them and ascertains whether they are working satisfactorily, and arranges for such repairs as are necessary. Arrangements of this kind for the repair of such implements and machinery as are used by *ryots* on the recommendation of the agricultural departments, should be tried by other provinces. In the Punjab the scarcity and dearness of labour have caused a large demand for agricultural machinery. The reduction of rates for the carriage of reapers and mowers sanctioned by the North-Western Railway should also help the introduction of these machines. Up to date about 130 reapers have been sold in the canal colonies, and their usefulness has been thoroughly tested in the field. To help the cultivators to use the machines a carefully compiled pamphlet was issued in the vernacular in which general directions were given for their use and repair. Mr. Milligan has evolved types of reapers and winnowers which are well-suited to the

conditions of the province. They will have a wide sale in the Punjab canal colonies as long as coolie labour is as scarce and dear as at present. A steam power thresher, manufactured by Messrs. Marshall Sons and Co., was tried this year at Pusa and also at Lyallpur under the supervision of an expert mechanic deputed by the company. The results at Lyallpur were only fairly satisfactory; clean even samples of grain and good *bhusa* were obtained, but the quantity of grain threshed in a working day was much less than was expected. The services of a trained *mistri* to help these trials were lent from Pusa. In Sind a modification of the native Egyptian plough and also a wooden scraper for levelling land are being widely distributed. Both of them are much needed to improve the practice of cultivation in Sind. A detailed description of these implements is given in the *Agricultural Journal of India*, volume IV, part I. There has been a good sale of improved machinery in the Central Provinces. Heavy turnwrest ploughs are in great demand in Berar where good bullocks are available. Harder's American winnower seems to be coming more into favour every year, as is attested by its sale to private persons. The establishment of agencies in the Central Provinces for the sale of machines tested by the department and for the supply of spare parts to replace breakages is under consideration. A large number of implements was issued from the seed and implements depôt maintained by the Bengal Department of Agriculture. Considerable discussion took place at the last meeting of the Board of Agriculture on the question of implement depôts. The discussion brought out the fact that the low price at which the departments supplied implements made it not worth the while of trade agencies to take up orders. The question of implement depôts will be brought up for separate discussion at the next meeting of the Board.

27. *Irrigation*—The promotion of well-sinking and other helps to irrigation has been engaging the attention of all local departments. The addition of an agricultural engineer to the staff of each agricultural department is

generally considered necessary for the direction of well-boring operations, construction of wells, dams, bunds and other works which may be considered from an engineer's point of view, of minor importance. The agricultural engineer should also demonstrate the advantages of various lifts and other irrigating plant, and give expert advice and assistance to cultivators. To some extent this question is now being solved in Bombay, the United Provinces, Madras and Bengal. Good progress has been made in the work of well-sinking in the United Provinces. A survey of wells was undertaken in that province to ascertain the localities where more masonry wells are needed, and also the nature of the obstacles which have hitherto interfered with construction. Important conclusions have been arrived at as a result of this enquiry. They are (1) that the demand for more wells is very large, and it increases with fresh facilities; (2) that what may be termed social obstacles to construction—inertia, hostility of landholders and the like—are relatively unimportant; (3) that difficulties of an engineering nature either in remedying the insufficiency of existing wells or in locating suitable sites for new construction, exist on a very large scale; (4) that lack of capital is by far the greatest obstacle in the way of the *ryots*. To cope with these engineering difficulties the Department of Agriculture, United Provinces, has now in its employ five subordinates whose duty it is to supervise the men engaged in boring and also to advise the public in all cases of difficulty. The labourers have been by practice trained to do the work of boring much more expeditiously and effectively than at first. A post of Agricultural Engineer has been created temporarily for the investigation of percolation wells, the structural improvement of chain pumps and the system of boring for water in rocky soils. An expert blaster has been employed in the Jhansi district whose services are available to cultivators on payment of a fee. He found ample work and secured valuable results in the rock wells of that district. In the Madras Presidency the conduct of the pumping experiments has continued under the control of Mr. Chatterton, Director of Industrial and

Technical Inquiries. Good progress has been made in the installation of new engines and pumps. Irrigation with water lifted by oil engines and pumps is making steady progress. The centre in which oil engine irrigation is most rapidly developing, is the south Arcot district where the soil is fertile, and there is also a very abundant supply of water in beds of coarse sand lying from 10 to 15 feet below the surface of the ground. The boring operations in the Chingleput district have revealed extensive supplies of sub-artesian water in some of its taluks. There is no longer any doubt about the advantages of this way of obtaining water, but its adoption is delayed only by the smallness of holdings and the lack of capital. Agricultural loans are granted by the Government of Madras to enable cultivators and land-owners to set up oil engines and pumps. A lift irrigation company has been formed with a capital of Rs. 12,000 to instal a pumping station on the banks of the Krishna western delta main canal to irrigate 500 acres of land too high to be commanded by direct flow. The Bombay Department of Agriculture has taken up the question of well-boring in the deep sandy soils of upper Gujarat as well as the question of water lifting from rivers and wells by various mechanical means. *Takavi* will be granted by Government to persons desirous of erecting mechanical pumping installations on any river or stream in the presidency, and no royalty will be charged on the water for a period of 25 years. Facilities for training fitters to keep such installations in order, have been made available at the Victoria Jubilee Technical Institute, Bombay, at the College of Science, Poona, and at the Methodist Episcopal Industrial Mission School, Nadiad. The services of a mechanic and a workman have been placed at the disposal of the provincial Director of Agriculture for the purpose of providing expert advice and assistance to agriculturists in connection with the use of mechanical pumps. The Ruston Proctor oil engine at Nadiad has proved to be economical as compared with the bullock *kos* except for very small areas. The water raised by it is more efficient, as the flow through the distributing channels

is maintained in a steady stream, the action of an oil engine being continuous. On this account the same amount of water raised by the oil engine goes about 33 per cent. further than an equal quantity of water raised by bullock leather bucket-lift in the water channels, the reason being that the soil is very porous, and with a slow flow much is lost by percolation. At Surat a new design of Ruston Proctor oil engine has been fitted up on one of the wells. It is a 6 horse power and is intended for driving not only a pump, but also a cotton gin, a chaff-cutter and a grain grinder. A very cheap and effective system of well-boring with a steel jumper bar, has been tested by the Collector of Ahmednagar. (See *Agricultural Journal of India*, volume III, part I.) The Imperial Department of Agriculture made a grant to the Central Provinces Department of Agriculture for setting up an oil engine in the Telinkheri gardens at Nagpur. This has not yet given satisfactory results, but the department is trying to remedy its defects. The same department has succeeded in getting the Cawnpore chain pump, a cheap and useful form of water lift made on the Raipur farm by the farm smith. It is capable of being worked by hand or by bullock gear and is more economical than the bullock bucket-lift for depth to water not exceeding 20 feet. Its parts are simple and are easily repaired locally when out of order. The Bengal Department of Agriculture has appointed a sub-overseer of the Public Works Department as superintendent of well-boring. He was sent to Cawnpore for training in this particular work. He is now employed in training well-borers, one for each district of the Bhagalpur and Patna divisions. When properly trained each will be entrusted with a complete set of boring tools and will work under the orders of the Collector. The question of the best means of applying irrigation water to fruit trees and important crops like tobacco, cotton, *ganja*, etc., is being studied by the Imperial Economic Botanist at Pusa. He has devised a method which combines the advantages of furrow irrigation, basin irrigation and irrigation by lateral seepage and, at the same time, allows of a proper surface tilth being maintained. This method is fully described in the *Agri-*

cultural Journal of India, volume III, part III. Experiments are in progress in most of the provinces to ascertain what quantity of water is required by each irrigated crop. Definite results have not yet been obtained, but the experience so far gained tends to show that small quantities supplied at short intervals, are more beneficial than copious flooding given at long intervals.

28. *The Reclamation of Alkali or "Reh" Lands*—These lands in several provinces in India are very extensive and, on the whole, are extremely barren. For many years efforts have been made to improve them. It cannot be claimed that much progress has been made. In many places the usual wealth-giving effect of canal water has, owing to excessive irrigation, produced excessive salt at the surface of the soil. But irrigation has, also in large degree, removed by drainage injurious salts from the surface and turned barren soil into land of very high permanent fertility. The question of infertility due to the incrustation of soluble salts at or near the surface in Indian soils, thereby often causing these soils to be barren, demands very special investigation by experienced men. The question was taken up by the Board of Agriculture at the last meeting in February 1909. A committee was suggested to the Government of India for preliminary investigations, and the whole subject will be brought up for general discussion at the Pusa meeting in February 1910. The committee will, if possible, prepare a "Reh" map for each province. Meantime, I refrain from commenting particularly on the subject, although I have stated separately that Mr. Henderson in Sind with experience in Egypt as a guide, is making satisfactory progress in reclaiming very salt land. He is helped to the extent of half the cost by funds supplied by my department.

29. *Sericulture*—Experiments in sericulture have made considerable progress in several provinces. In Bengal the direction of sericulture has been placed under the control of a small managing committee with the Director of Agriculture as President and the Collector of Murshidabad and three silk factors as members. The Superintendent,

Mr. A. K. Ghosh, is in direct charge of the work. A large central nursery has been established at Berhampore to supply selected seed to rearers and to teach correct methods of rearing, also improved methods of cultivation of various varieties of mulberry and the detection of disease under the microscope. Model nurseries have been opened in Bengal at different silk centres. Mr. T. F. Martin, Manager of Ganatia factory, is encouraging improved methods in Birbhum. Excellent seed was distributed from the nursery at Rammati and from those in Murshidabad to local rearers and those of other districts. The experiments conducted by Mr. Ghosh in connection with the cold storage of seed cocoons, have been successful.

In June 1908, four scholarships of Rs. 5 each per month were founded at the sericultural school at Sabang in the Midnapore district, and a microscope was purchased at the expense of the Government. The scholars are reported to have learnt their work fairly well. The silk industry promises to have a good future in the Khasi hills of Eastern Bengal and Assam. The cocoons from silk worms reared in these hills were favourably reported on by silk experts. The agricultural department of the province is developing the system of rearing silk worm seed and of selling disease-free seed to silk worm rearers.

In the Punjab the mulberry tree grows extremely well with irrigation and is fairly common. But there are certain difficulties in the way of silk worm rearing in that province. The sudden advent of very hot weather in early April kills the worms if cocoons have not been formed in time. Experiments will be undertaken to determine whether a silk industry can be established in a practical way in all the most suitable parts of the province. Disease-free eggs will at first be supplied gratis to rearers.

A *tussar* farm has been sanctioned at Arsoda in the Chanda district of the Central Provinces. The object is to supply good seed to rearers. Wild cocoons are obtained from the forests, through the Forest Department. The worms are reared during the rains in domestication. The produce is distributed to rearers in the autumn. One

object of this work is to discover whether it is possible to rear the worms year after year under somewhat artificial conditions at a central experimental station. In Kashmir, sericulture has established itself as a very paying industry. More than 30,000 mulberry trees were planted during the period. The demand for seed from Europe is increasing with the expansion of the silk industry. The number of rearers has also very substantially increased. The Durbar proposes to extend silk rearing in some parts of Jammu. Two new filatures have replaced those burnt by fire. They are being fitted up with electric power from the Jhelum for the sake of economy in various processes.

The progress of sericultural operations at Mastung in Kelat, Baluchistan, has been very satisfactory. A large amount of raw silk is now produced, and there is a better outturn in cocoons of good size and weight as a result of the improved arrangements made for the accommodation and feeding of the worms. But the chief difficulty is in regard to the adequate supply of mulberry leaves. Unlike Kashmir the fruit of the mulberry in Mastung commands a good market price. The fruit does not come to perfection if the leaves of the trees are periodically cut.

Work on *eri*-silk was continued at Pusa and a very large crop was obtained. Many varieties of castor were tested regarding their suitability for feeding the worms. The questions of reeling the silk, of dyeing it with indigenous dyes and of weaving it, have been taken up. The Pusa work will be determined by its adaptability for a rural or cottage industry.

At Benipore Sakri, Behar, the manager has started *eri*-silk as a small industry for *ryots* only, and the industry is extending.

The Baroda State carries on sericultural operations in the Tapti valley. The Songhad farm has been fully equipped. It supplies eggs and mulberry cuttings and buys the produce. This farm obtained eggs from Pusa and successfully obtained two crops during the year, and owing to the success obtained the industry is extending in

the direction which is most desirable, *viz.*, to help poor people.

30. *Poultry-breeding*—The scope of improved poultry-breeding in India was discussed by the Board of Agriculture in 1908. The Board recommended that breeds of good utility poultry suitable for India should, in a practical way, be dealt with at Pusa. The work has, therefore, been taken up in a practical way with such imported and indigenous breeds as are likely to improve the poultry industry in India. We expect some failures at the start, but in this regard we have paid attention to the best expert advice that India can give. We are dealing with many varieties of cocks and hens and their crosses, also turkeys, geese and ducks, and will soon deal with their crosses. We have imported brown and white Leghorns, black Minorcas, barred Rocks, also Wyandottes and Orpingtons of the various strains and bronze turkeys, Embden geese and Aylesbury ducks. For crossing, various kinds of Indian fowls have been selected. All the imported birds arrived in excellent condition. This year there are nineteen pens of breeding fowls besides geese, ducks and turkeys. We intend to maintain the vigour of the pure English breeds by importing new blood year by year. This in the present season has been arranged for, and a few more breeds will be added to our list including English bred Indian game. The Board of Agriculture in the year 1908 also recommended that the work should be extended through the provincial agricultural departments and all other useful agencies. Mr. Shearer, Assistant Inspector-General of Agriculture in India, continues to be in charge of the poultry-breeding at Pusa and will reply to all applications for fowls or eggs. Some of the provincial agricultural departments have already been supplied with breeding pens, and a large demand from private fanciers has sprung up.

31. *Agricultural Education*—The Agricultural College at Pusa was opened in July 1908, and 19 students were admitted for training in the various sections. Twelve of them have left after completing their course. At present there are nine students undergoing training at Pusa. The

arrangements in each section are complete for advanced teaching and research work. There is no need now to send Indian students to foreign countries to specialize in agricultural subjects. As a temporary measure to assist provinces which have no regular agricultural colleges, arrangements have been made to give a two years' general course in agriculture. It has also been arranged to offer at Pusa short special courses in subjects which are likely to directly benefit the Indian cultivator. Six out of eight men deputed by the Bengal Government to an American agricultural college have returned to India; four of these are now employed in the agricultural departments of Bengal and Eastern Bengal and Assam. The Poona Agricultural College has gone through its first year as an independent institution. It has a large number of students and is doing good work. The Bombay department is making efforts to get the right class of students. The Lyallpur Agricultural College will be opened on the 1st September 1909; there have been many applications for admission. Of these, 16, all young men connected with the land, have been accepted. The foundation stone of the Sabour Agricultural College was laid by Sir Andrew Fraser in August 1908. The construction of the buildings will be complete by June 1910, and classes will be opened by November 1910. Pending the opening of the provincial agricultural college four students have been given stipends to study agriculture in colleges in other parts of India, one at Poona, two at Nagpur and one at Cawnpore. The Agricultural Department of Eastern Bengal and Assam have sent three students with stipends for a three years' course of training at the Poona College of Agriculture. The department propose to provide a two years' practical course at the Dacca farm for training sons of cultivators. The new Coimbatore Agricultural College was opened in July 1909 with a full class of students. The Government of Burma have, for the present, abandoned the idea of establishing an agricultural college at Mandalay owing to the straitened condition of provincial finances. A standard curriculum for provincial colleges framed by the Board of Agriculture in 1906, and revised by the

Board of Agriculture in 1908, has been published. Dr. Butler has made arrangements for unifying the proposed mycological courses in the provincial colleges, and as a basis for this unification a memorandum on a course of lectures and practical work as well as on the most important diseases, has been compiled. According to the recommendation of the Board of Agriculture held at Nagpur, a standing committee will be formed to advise on the progress of, and difficulties in, agricultural education at Pusa and the provincial colleges. Provincial colleges will be represented on the committee which will include at least one Director of Agriculture and an educational expert. The committee will meet biennially in connection with the Board of Agriculture.

During the period under report Pusa continued the work of training probationers sent up by the provinces. The Assistant Professor of Botany at the Poona College of Agriculture received a short course in mycology in April and May 1908. At the request of the Civil Veterinary Department, Bengal, Mr. P. G. Patel was sent to Belgachia to give a course of instruction on biting flies injurious to cattle. Messrs. P. N. Dass and Syed Mohammad Raza Hossain of the civil veterinary departments of Bengal and the United Provinces, respectively, came to Pusa for instruction in methods of observing and collecting pests and parasites of cattle and other stock. Mr. Gore, Manager of the Salvation Army's farm in Gujarat, came for a short practical course last cold weather.

Training in methods of illustration was also given at Pusa to Chimaswami Pillay, an artist, sent by the Government of Madras.

32. *Publications*—A complete list of publications issued by the Imperial Department of Agriculture during the years 1907-08 and 1908-09 is given in Appendix C. The Imperial Department alone published 10 bulletins and 23 scientific memoirs on various subjects. For facility of reference this list also includes such important publications on agriculture as have been published by other departments and persons interested in agriculture. The *Agricultural Journal of India* and the scientific memoirs

have continued to increase in popularity. There has been considerable increase in the list of subscribers to the journal, and it promises to fulfil the aim with which it was started. Imperial and provincial experts have freely contributed to these publications. My thanks are no less due to other Government officials and private persons interested in agriculture who have occasionally sent contributions. A large number of copies of these publications are given free to learned societies and interested individuals in all countries. The Imperial Department gets in return free copies of publications issued by them. The exchange list has now been considerably extended to enable the Department to keep in touch with the progress that is being made by agricultural departments in other countries. Mr. Lefroy's important work, *Indian Insect Life*, which is beautifully illustrated, has just been published. Mr. Howard's *Monograph on Indian Wheats* is now in the press. The first publication treats of insects, both beneficial and harmful, of the cultivated plains of India. It will be a standard work of reference and ought to prove of immense benefit to Indian agriculture. The other contains the results of four years' solid work done on Indian wheats. It will, no doubt, prove very useful to the trade and the educated cultivating classes.

33. *Expenditure*—The expenditure incurred by the Imperial Department of Agriculture during 1907-08, and 1908-09 was Rs. 3,73,698 and Rs. 4,30,714 respectively as detailed below against Rs. 3,34,925 incurred in 1906-07 :—

	1907-08.	1908-09.
	Rs.	Rs.
Inspector-General of Agriculture	86,475	89,385
Director, Pusa	64,365	82,156
Chemical Section	34,804	47,043
Mycological Section	28,559	36,598
Entomological Section	42,880	44,907
Second ditto	8,688	18,858
Bacteriological Section	6,529	403
Agricultural Section	69,878	62,569
Botanical Section	28,130	31,389
Cotton Specialist	3,390	17,406
TOTAL	3,73,698	4,30,714

There is thus an increase of Rs. 38,773 in 1907-08 and of Rs. 95,789 in 1908-09 over the expenditure of 1906-07. This increase is due to the expansion of the department. This includes special grants placed at the disposal of the Inspector-General of Agriculture for such special agricultural investigations as he thinks desirable. The principal items of expenditure from this special grant were as under :—

Particulars.	1907-08.	1908-09.
	Rs. A. P.	Rs.
Grant to the Indian Tea Association	15,000 0 0	15,000
Grant-in-aid to the Department of Agriculture, Bombay—		
(i) For reclamation of Kalar land in Sind	7,900 0 0	6,500
(ii) Sugarcane experiments at Manjri, Bombay	856 14 11	...
(iii) Construction of a well on the Surat farm to safeguard hybrid cottons in years of drought.	...	1,000
Grant-in-aid to the Director of Agriculture, Madras, for cotton seed.	515 9 0	...
Purchase of bees and appliances	1,766 11 0	...
Purchase of cows for Pusa	500 0 0	...
Sericulture experiments at Pusa	100 0 0	100
Poultry-breeding experiments at Pusa	1,139 14 6	2,872
Expenditure on date palm cultivation in Sind	937 15 1	...
Paid to Behar Indigo Planters' Association for pay of Flax Expert.	...	2,750
Miscellaneous purchase of seeds, implements and other requirements for experiments, etc.	2,568 6 7	6,973
TOTAL	31,285 7 1	35,195

34. *Expansion of the Department*—The agricultural departments in India have continued to develop on the lines indicated in the report of 1904-05. The proposals to strengthen the staff of European specialists sanctioned during the last year, have been generally carried out. In view of extensive developments which are certain to occur, further expansion of the department is essential, and I will particularly aim to improve the pay and prospects of the subordinate Indian staff. The agricultural

departments in all provinces are gaining the confidence of the public, and their advice is freely sought and acted upon. The problem of reaching the practical farmer is difficult in all countries, but it is more so in India, where the cultivators as a class are generally illiterate and conservative. Attempts are being made by agricultural departments in all provinces to arouse the interest and enlist the sympathy of cultivators by such practical means as the holding of agricultural and cattle shows, the formation of agricultural associations and the establishment of agricultural stations, demonstration areas and seed farms. Efforts are also being otherwise made to bring home to cultivators the results of proved value obtained on Government farms. The progress made by the departments in various provinces bears a striking testimony to the zeal with which the European and Indian staffs have done their work.

A brief account of the work done in each province and of indigo research in Behar is given in Appendices A and B.

J. MOLLISON, M.R.A.C.,
Inspector-General of Agriculture in India.

SIMLA E.,
The 5th August 1909.

APPENDIX A.

THE AGRICULTURAL STAFF AND WORK IN EACH PROVINCE.

Bombay—The superior staff of the department underwent a considerable change from the Director downwards which naturally involved a considerable break in continuity of work. Mr. Fletcher left the department in September 1907, and his place has since been filled by Mr. T. F. Main who was working in the Imperial Department of Agriculture as Assistant Inspector-General of Agriculture in India. Mr. Meggit, Agricultural Chemist, was transferred to Eastern Bengal and Assam in November 1907 when Dr. H. H. Mann took over charge of the duties of Agricultural Chemist and Principal of the Agricultural College, Poona. The post of Economic Botanist rendered vacant on the appointment of Mr. Gammie as Imperial Cotton Specialist, has been filled by Mr. Burns. The three sanctioned posts of Divisional Inspectors have been filled by experienced men of the department. Experiments in the methods of dry farming have been commenced at Rahuri in Ahmednagar district, a short description of which has been published in the *Agricultural Journal of India*. Arrangements are being made to start several sub-stations for experiments on jute, aloes, Broach cotton, American cotton, wheat and linseed. Two new branches have recently been added to the department, one for well-boring in the deep sandy soils of upper Gujarat, the other to take up the question of water lifting from rivers and wells by various mechanical means. An agricultural exhibition of a general and comprehensive nature was organised by the department in connection with the provincial conference at Dhulia. The trials with lemon grass at the Bassein botanical gardens have given very successful results. It is proposed to attempt the extraction of citronella oil, as the profits obtainable therefrom are remarkably large. Cassava is being tried in several localities to estimate its exact value as a field crop under different conditions. At Daulatpur in Sind, operations for the reclamation of 400 acres of alkali land classed as "unculturable kalar" are in progress. The department biennially holds a conference in different parts of the Presidency and brings the leading cultivators and others interested in agriculture into touch with the work of the department.

Madras—There was no addition to the superior staff of the department, but the need of a Mycologist is strongly felt, as there are many diseases affecting valuable crops in the Presidency that require immediate investigation. The local Government has accordingly submitted proposals for the appointment of a European Mycologist in Madras. Two posts of Assistant Directors on Rs. 250—15—400 have been created in the department. Their duties will be to constantly visit the agricultural stations and inspect the work of the subordinate agency. The head-quarters of the Deputy Director of Agriculture, southern division, have been fixed at Trichinopoly, and those of the Deputy Director of the northern division are at present at Bellary. The Attur agricultural station has been given up, as it appeared that no useful work could be done there. The abandonment of the Bellary agricultural station has been proposed to Government, the land being unsuitable for experimental work. The Hagari agricultural station will now become the centre for work on the cottons of the variety known to the trade as "westerns", and the work on the improvement of the local cottons commenced at Bellary will be transferred there. The District Board farm at Bezwada has been taken over by the department. Natural pasture grasses are being studied under cultivation at Taliparamba where fodder for cattle in the dry weather is a great want. Five agricultural apprentices sent by private individuals and agricultural associations were trained in farm work at the Koilpatti farm. Mr. Chatterton continued to help the department, and under his supervision the introduction of lift irrigation by oil engines and pumps made good progress. The department has lost an enthusiastic worker in the death of Rao Bahadur C. K. Subba Rao.

United Provinces—The province has been divided into three filled in October 1907 the second post of Deputy Director of Agriculture; left the department towards the end of May 1908 on the termination of his agreement. He was succeeded by Mr. B. C. Burt who has been put in charge of the central circle. Dr. Parr filled in October 1907 the second post of Deputy Director of the western circle. Khan Bahadur Syed Mohomed Hadi is in charge of the eastern circle. Mr. A. C. Chatterjee, I.C.S., was attached to the department on special duty in connection with promotion of industries. There are four agricultural stations in existence at Cawnpore, Orai, Aligarh and Partabgarh, and two more at Attara and Benares are being organised during the year. Attara is situated in a part of Bundelkhand and is designed to pioneer the improvements in the local agriculture rendered possible by the introduction of irrigation in that part. A post of Agricultural Engineer has been created temporarily.

The investigations of the Agricultural Engineer have related mainly to percolation wells, to the structural improvements of chain pumps and to the system of boring for water in rocky soils. The appointment of a European Horticulturist for the Kumaun Himalayas has been sanctioned, and a central station at Douglasdale near Naini Tal has been partially organised. The object is to develop the fruit and vegetable production in the hills mainly to supply the markets of the plains during the hot weather. The department co-operated in the creation of a central station for poultry-breeding in the Rampore State which is now at work. There has been a rapid increase in the demand for chain pumps for lifting water from canal distributaries. The maize-sheller designed by Mr. Hayman has become very popular. The seed depôts continued to do useful work in the way of supplying good seed to cultivators on credit. A beginning has been made during the year with a scheme of horticultural education at Saharanpur and Lucknow.

Bengal—Mr. W. R. Gourlay, I.C.S., has been in charge of the department since the transfer of Mr. C. E. A. W. Oldham as Financial Secretary to the Government of Bengal. Mr. C. S. Taylor and Mr. E. J. Woodhouse joined the department as Agricultural Chemist and Economic Botanist after undergoing preliminary training in their subjects at Pusa and Poona, respectively. The charge of the home farm attached to the Agricultural College at Sabour has been made over to the Principal. There are at present six Government agricultural stations, *viz.*, Sabour, Bankipore, Cuttack, Fraserganj, Chinsura and Chaibasa and two private stations—Burdwan and Dumraon. Besides, there is a demonstration farm at Kalimpong, towards the upkeep of which Government contributes an annual grant. It is in contemplation to establish two more stations, one at Kharagpur, to represent the laterite area in Lower Bengal, and one at Ranchi, to represent the peculiar agricultural conditions of the Chotanagpur plateau.

The department started a quarterly journal of agriculture in English in July 1907. Numerous leaflets on various subjects connected with agriculture were prepared during the period under report and were widely circulated. A scheme for the extension of well irrigation in Behar was sanctioned, and a Sub-Overseer of the Public Works Department was appointed superintendent of well boring and was deputed to Cawnpore for training. He is now employed in training twelve borers, one for each district of Bhagalpur and Patna divisions.

Punjab—The European staff was strengthened by the appointment of Mr. Milne as Economic Botanist in 1907. Mr. Dobbs,

Principal of the Lyallpur College, was transferred to Bengal, and Mr. H. H. Corbin was appointed Professor of Agriculture, the post of Principal being given to Mr. J. H. Barnes. The work of the Agricultural Chemist has been hampered for the want of a complete laboratory at Lyallpur. Temporary arrangements were, therefore, made for his work at Pusa. A large subordinate staff of Assistant Directors, Assistant Professors, and other assistants has been sanctioned. Land for a second agricultural station is being acquired in the Jullunder district.

The attention of the department is largely directed towards the introduction of labour saving agricultural machinery, as there is a real demand for improved implements on account of the scarcity and dearness of labour. (*Vide* paragraph on Distribution of Implements.) The noticeable features of work connected with the improvement of important crops such as cotton and wheat, are referred to under the respective crops. The Reh problem which is assuming increasing importance in the province is receiving full attention of the department. The Punjab department is young and, though full of energy, is still largely in the stages of recruitment, organization and enquiry.

Central Provinces—The post of Director of Agriculture in the Central Provinces was held by no less than three officers during the period under report. The department was strengthened by the appointment of Mr. Allan as Principal of the Agricultural College, Nagpur, and of Mr. Graham as Economic Botanist. Mr. Evans has been posted as Deputy Director of the northern circle with his head-quarters at Hoshangabad. There are four agricultural stations in these provinces—Nagpur, Raipur, Hoshangabad and Akola. A small farm at Damoh has been opened for demonstration purposes. The Raipur farm has been enlarged in order to provide more land for a cane seed farm. The establishment of a *tussar* farm near Arsoda in the Chanda district has been sanctioned. The most important work of the department was the successful demonstration of the advantages of transplantation and irrigation of rice in Chhattisgarh. The department organised with complete success on a very large scale the agricultural section in connection with the Central Provinces and Berar Industrial and Agricultural Exhibition that was held at Nagpur in 1908. Advantage was taken at this exhibition to demonstrate the most useful implements as well as the varieties of local crops, the composition of soils and manures and insect pests. (For fuller description *vide* the *Agricultural Journal of India*, volume IV, part II.) Mr. Evans has published an interesting bulletin on the potato crop. The department is making experiments with the object of deepening and improving the wells in the trap rock of

Nimar and the Vindhian sandstone of Damoh. The agricultural associations continued to assist in the introduction of new varieties of crops and of improved methods of conserving manure and the use of artificial manures. The department has succeeded in gaining to a large extent the confidence of the *ryots*. Its advice and assistance are freely sought.

Eastern Bengal and Assam—The superior staff was strengthened by the appointment of Mr. A. A. Meggit as Agricultural Chemist in December 1907. Mr. G. P. Hector has been appointed Economic Botanist after undergoing training at Pusa. Mr. M. M. Chakrabarti who has been trained in sericulture in the University of Tokio, has been appointed Superintendent of Sericulture. The department has succeeded in enlisting the co-operation of practical and enthusiastic gentlemen as honorary associates. These men do practically the same work as agricultural associations in other provinces. There are seven agricultural stations in the Province, *viz.*, Dacca, Rajshahi, Burirhat, Jorhat, Shillong, upper Shillong and Wahjain. A new tobacco station was opened during the year at Burirhat, some six miles distant from Rangpur, as the latter station was found unsuitable for the purpose. Experiments in spraying diseased potatoes with Bordeaux mixture have proved very successful. At the upper Shillong station, Patna bulls have been used to cross with the local breed. The Imperial Mycologist is investigating the blight disease of orange trees which is spreading in the Khasi hills.

Burma—Mr. J. MacKenna, I.C.S., remained in charge of the department throughout the period under report. Mr. E. Holmes-Smith who has been recruited to fill the post of Agricultural Economic Botanist of the Province, is undergoing training at Pusa. The cultivation of groundnut has very largely extended during the period (as noticed under groundnut). An investigation into the possibility of introducing in the dry zone of the upper Burma the cultivation of drought-resisting crops has been taken in hand. A scheme has been framed for a series of experiments on the utilization of river silt on the lines of Sir Edward Buck's proposals. Owing to the financial stress there will now be only one farm at Mandalay. The proposals to acquire a farm at Hmwabi or in the dry zone, are at present in abeyance.

LIBRARY OF THE BOMBAY BRANCH

APPENDIX B.

INDIGO RESEARCH WORK IN BEHAR.

1. The Research station at Sirsiah is fully equipped for work both in regard to the laboratory and the field.

A practical dye test of natural *versus* synthetic indigo was carried out at Cawnpore Woollen Mills. The result was reported to be in favour of natural indigo. Further tests are being carried out to confirm this. The relation between the temperature of water, time of steeping and the rate of loading the vats, has been determined after varied experiments. Lighter loads have been found to give a higher efficiency particularly with plant rich in colour-yielding material. The influence of the addition of alkalies and alkaline substances to the steeping vats, was tried and compared with the results obtained with the patent alkaline of glucosode. The average percentage of efficiency and quality of yield in the glucosode process were found to be lower than those in the ordinary process. It was shown that "mahai" could be carried out late in December, if the area of plant for cutting is sufficiently large. A machine for filtering silt water was tried, but did not give very satisfactory results. A machine for preparing indigo powder was tried. Certain defects in its working have to be corrected. It is desirable that natural indigo should be put on the market in the form of a fine powder, or in as convenient and reliable a form as the synthetic substance. The manurial experiments showed that the application of chemical manures has no special advantage in increasing indican production, but the growth of the plant is thereby stimulated. Indican production thus appears to be independent of manurial treatment and to accompany more or less starvation conditions. But the fertility of the land should not however be allowed to go below a certain limit, and it is essential to maintain a good physical condition of the soil, otherwise the development of the plant is arrested, and although its colour-content may be very high, the return per acre is affected. Some trials of the effect of various plant stimulants on the production of indican are now in progress. A start has been made in the selection of Java plant by analysing the leaf from a large number of individual plants. The superiority of Java plant over the old Sumatrana variety in Behar is now well established. The method of treating the Java seed with sulphuric acid with some

modifications, has been generally adopted and found successful. The Java variety is a perennial and is, therefore, specially liable to the attacks of pests.

2. The analyses of various plants indicated that considerable differences in dye-yielding power depended on botanical characteristics. The whole of the biological side of the work has yet been barely touched upon.

To put indigo research on a satisfactory footing the services of an expert in plant physiology and breeding are absolutely essential. It will take 4 to 5 years before any definite practical results are obtained from this line of work. With the annual subsidy of Rs. 32,500 promised by the Government of Bengal for five years from 1909, the Behar Planters' Association have been enabled to retain the services of Mr. Bergtheil who has resigned Government service. He is the only available expert now fully qualified to take charge of the work. The main work of the station will now be the improvement of the indigo plant by selection and breeding, and the study of the causes which lead to the production of indican in the plant with a view to evolving a method of stimulating its production. Selection and breeding will be chiefly directed towards the production of a plant capable of yielding a maximum amount of indigo, but the need for evolving plants of high seed yielding capacity and of powers of resistance to disease, drought, etc., will not be lost sight of. Work will also be continued on the manufacture of indigo in powder form with the recently imported drying machine erected at Barrah factory. It is not proposed for the present to carry out any work on the production of indigo in the vats, as Mr. Bergtheil is of opinion that nothing more is to be gained. Further investigations by independent workers may justify the opening up of the subject later on.

APPENDIX C.

List of Agricultural Publications in India during 1907-08 and 1908-09.

No.	Title.	Author.	Where published.
	General Agriculture.		
1	Annual Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, 6 annas.	Inspector-General of Agriculture in India, Nagpur, Central Provinces.	Government Printing, India, Calcutta.
2	Proceedings of the Board of Agriculture in India, 1908. Price, 8 annas.	Ditto	Ditto.
3	*Agricultural Journal of India*, Vol. III. Parts I—III. Price, Rs. 2 for each part. Annual Subscription Rs. 6 per annum.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
4	Standard Curriculum for Provincial Agricultural Colleges as recommended by the Board of Agriculture. Price, 4 annas.	Inspector-General of Agriculture in India, Nagpur, Central Provinces.	Government Printing, India, Calcutta.
5	Indian Cotton Seed : Its Industrial Possibilities. Price, 12 annas.	Frederic Noël-Paton, Director-General of Commercial Intelligence, India.	Ditto.
6	Proceedings of the Veterinary Conference held at Calcutta on the 10th, 11th and 12th February, 1908.	Inspector-General, Civil Veterinary Department, Simla.	Ditto.
7	Agricultural Statistics of India from 1901—1905-06. Price, Rs. 3-8.	Director-General of Commercial Intelligence.	Ditto.
8	Sun Flower in India—*Agricultural Ledger* No. 1 of 1907. Price, 2 annas.	David Hooper, F.I.C., F.C.S., Superintendent, Industrial Section, Indian Museum, Calcutta.	Ditto.
9	Causes of Hardness in the Seeds of Indigofera arrecta.	C. J. Bergtheil, Imperial Bacteriologist and D. Day.	
10	Heeleaka Experimental Station : Investigations during 1905 and 1906.	Harold H. Mann, D.SC., F.I.C., F.L.S., Scientific Officer to the Indian Tea Association.	Indian Tea Association, Calcutta.
11	Second Report on the Sugar Mill at Benipur Factory.	Percy Jones . .	Behar Planters' Association, Mozufferpore.

List of Agricultural Publications in India during 1907-09 —contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
12	Annual Report of the Behar Planters' Association for 1906-1907.	Behar Planters' Association.	Behar Planters' Association, Mozufferpore.
13	Report of the Indigo Research Station, Sirsiah, for 1907-1908.	C. J. Bergtheil, Imperial Bacteriologist.	Ditto.
14	Third Annual Report of the Behar Planters' Association, Sirsiah Sub-Committee, from 1st July 1907 to 31st December 1907.	Behar Planters' Association.	Ditto.
15	Third Report on the Sugar Mill at Benipur Factory.	Percy Jones	Ditto.
16	Review of information on Burmese Peas and Beans so far collected in the office of the Reporter on Economic Products to the Government of India.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India.	Government Printing, India, Calcutta.
17	Conservation of Farm Yard Manure. Leaflet No. 7 of 1907.	Department of Agriculture, Bengal.	Department of Agriculture, Bengal, Calcutta.
18	Ensilage for paddy. Leaflet No. 8 of 1907.	Ditto	Ditto.
19	Weeds and their Suppression. Leaflet No. 9 of 1907.	Ditto	Ditto.
20	Bonemeal and Saltpetre as manure for paddy. Leaflet No. 10 of 1907.	C. A. Oldham, I.C.S., Director of Agriculture, Bengal.	Ditto.
21	Short note on the Cultivation of Mangel Wurzel. Leaflet No. 11 of 1907.	Ditto	Ditto.
22	Cassava. Leaflet No. 12 of 1907.	Department of Agriculture, Bengal.	Ditto.
23	Short instructions for the Improvement of Cotton by plant to plant selection. Leaflet No. 13 of 1907.	C. A. Oldham, I.C.S., Director of Agriculture, Bengal.	Ditto.
24	Jute Experiments in Bengal. Leaflet No. 1 of 1908.	F. Smith, B.SC., Deputy Director of Agriculture, Bengal.	Ditto.
25	Oats. Leaflet No. 2 of 1908	Ditto	Ditto.
26	Wheat. Leaflet No. 3 of 1908	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
27	List of Crops Recommended for Cultivation. Leaflet No. 4 of 1908.	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal, Calcutta.
28	The Bengal Seed, Manure and Implement Store. Leaflet No. 5 of 1908.	Department of Agriculture, Bengal.	Ditto.
29	*Quarterly Journal* of the Agricultural Department, Bengal, Vol. I, Nos. 1—4. Price, Rs. 2.	Ditto	Bengal Secretariat Book Depôt, Calcutta.
30	Annual Report of the Agricultural Department, Bengal. for the year ending 30th June 1907. Price, 8 annas.	Ditto	Ditto.
31	Annual Report of the Burdwan Experimental Station for the year 1906-07. Price, 4 annas.	Ditto	Ditto.
32	Annual Report of the Dumraon Experimental Station for the year 1906-07. Price, 2 annas.	Ditto	Ditto.
33	Annual Report of the Cuttack Experimental Station for the year 1906-07. Price, 2 annas.	Ditto	Ditto.
34	Season and Crop Report of Bengal, 1907-08. Price, 8 annas.	Ditto	Ditto.
35	Agricultural Statistics of Bengal. Price, 8 annas.	Ditto	Ditto.
36	Manual of Rules for the preparation of crop reports and Agricultural Statistics in Bengal (not for sale).	Ditto	Bengal Secretariat Press, Calcutta.
37	Statement showing the normal areas under the principal crops in each district and the percentage of these areas on the normal net cropped area of the district (not for sale).	Ditto	Ditto.
38	Jute in Bengal . . .	N. C. Chowdhry .	Muzumdar Library, Calcutta.
39	List of local names of varieties and races of sugarcane grown in Bengal (not for sale).	Department of Agriculture, Bengal.	Bengal Secretaria tPress. Calcutta.
40	A short note on wheat survey of Bengal. Departmental Record No. 2 (not for sale).	D. N. Mukerji, M.A., M.R.A.C.	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
41	Catalogue of exhibits of the Bengal Agricultural Department in the Indian Industrial and Agricultural Exhibition, 1906-07 (not for sale).	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
42	Report on enquiry into the decline of the silk industry of Bengal.	Ditto	Ditto.
43	Monograph on breeds of cattle of Darjeeling district (not for sale).	D. Quinlan, M.R.C.V.S., Superintendent, C. V. Department, Bengal.	Ditto.
44	Report of the Patna Divisional Agricultural Association for the year ending 30th June 1908.	Patna Divisional Agricultural Association.	Patna Divisional Agricultural Association, Bankipore.
45	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1907. Price, 8 annas.	Department of Agriculture, United Provinces of Agra and Oudh.	Government Press, United Provinces of Agra and Oudh, Allahabad.
46	Annual Report on the Cawnpur Agricultural Station for the year ending 30th June 1907.	Ditto	Ditto.
47	Annual Report on the Jalaun (Orai) Agricultural Station for the year ending 30th June 1907. Price, 8 annas.	Ditto	Ditto.
48	Annual Report of the Aligarh Agricultural Station for the year ending 30th June 1907. Price, 8 annas.	Ditto	Ditto.
49	Annual Report of the Department of Agriculture, Punjab, for the year 1906-07. Price, 3 annas.	Department of Agriculture, Punjab.	Civil & Military Gazette Press, Lahore.
50	Annual Report of the Lyallpur Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto	Ditto.
51	Annual Report of the Government Agri-Horticultural Gardens, Lahore, for the year 1907-08.	Ditto	Ditto.
52	Season and Crop Report of the Punjab for 1906-07. Price, 9 annas.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
53	Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1906-07. Price, 4 annas.	Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
54	Annual Report of the Experimental Work of the Surat Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto	Ditto.
55	Annual Report of the Experimental Work of the Nadiad Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto	Ditto.
56	Annual Report of the Experimental Work of the Dharwar Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto	Ditto.
57	Annual Report of the Experimental Work of the Dhulia Agricultural Station for the year 1906-07. Price, 4 annas.	Ditto	Ditto.
58	Annual Report of the Poona Agricultural Station for the year 1906-07, including Kirkee Civil Dairy and Lanowli Agricultural Stations. Price, 7 annas.	Ditto	Ditto.
59	Annual Report of the Manjri Agricultural Station and the Baramati Demonstration Station for the year 1906-07. Price, 5 annas.	Ditto	Ditto.
60	Annual Report of the Ganeshkhind Botanical Station for the year 1906-07. Price, 5 annas.	Ditto	Ditto.
61	Annual Report of the Bassein Botanical and Agricultural Station for the year 1906-07. Price, 4 annas.	Ditto	Ditto.
62	Annual Report of the Mirpurkhas Agricultural Station for the year 1906-07. Price, 3 annas.	Ditto	Ditto.
63	Season and Crop Report of the Bombay Presidency for the year 1906-07. Price, 7 annas.	Ditto	Ditto.
64	Proceedings of the Agricultural Conference held at Ahmedabad in November 1907. Price, 7 annas.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
65	Poona Agricultural College Calendar for the year 1908-09.	Department of Agriculture, Bombay Presidency.	Shri Shetkar Press, Poona.
66	Report on the Operations of the Department of Agriculture, Madras, for the year 1906-07. Price, 8 annas.	Department of Agriculture, Madras.	Government Press, Madras.
67	Scientific Report of the Attur Agricultural Station for the year 1906-07. Price, 2 annas.	Ditto	Ditto.
68	Scientific Report of the Hagari Agricultural Station for the year 1906-07. Price, 4 annas.	Ditto	Ditto.
69	Scientific Report of the Bellary Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto	Ditto.
70	Scientific Report of the Palur Agricultural Station for the year 1906-07. Price, 3 annas.	Ditto	Ditto.
71	Scientific Report of the Koilpatti Agricultural Station for the year 1906-07. Price, 6 annas.	Ditto	Ditto.
72	Scientific Report of the Samalkota Agricultural Station for the year 1906-07. Price, 3 annas.	Ditto	Ditto.
73	Notes on Fig cultivation in South India and peculiarities in Viticulture in Penukonda in the Anantpur district. Bulletin No. 57. Price, 1 anna.	Rao Bahadur C. K. Subba Rao, B.A., Ag. Government Botanist, Madras.	Ditto.*
74	The cultivation of Groundnuts. Bulletin No. 58. Price, 9 pies.	H. C. Sampson, B.SC., Deputy Director of Agriculture, Southern Circle, Madras Presidency.	Ditto.
75	Note on Jute cultivation (in Tamil). Leaflet. Distributed free to ryots.	Ditto	Ditto.
76	Madras Agricultural Calendar, 1908. Price, 0-1-6.	Department of Agriculture, Madras.	Ditto.
77	Note on How to water fruit trees. Leaflet with Tamil and Telegu translations. Distributed free to ryots.	Ditto	Ditto.

* With Tamil and Telegu translations.

List of Agricultural Publications in India during 1907-09—contd.

No	Title.	Author.	Where published.
	General Agriculture—contd.		
78	The introduction of improvements into Indian Agriculture. Leaflet.	D. Clouston, M.A., B.SC., Deputy Director of Agriculture, Central Provinces.	Secretariat Press, Nagpur.
79	Sann-hemp, Ambari and Agave as fibre crops in the Central Provinces. Leaflet.	Ditto	Ditto.
80	Seoner Juar. Leaflet	Ditto	*Dessewak* Press, Nagpur.
81	Safeda. Leaflet	Ditto	Ditto.
82	Medium Paddy. Leaflet	Ditto	Ditto.
83	Raskadam and Nasick early paddies. Leaflet.	Ditto	Ditto.
84	Gurmatia, late paddy. Leaflet	Ditto	Ditto.
85	Groundnut. Leaflet	Ditto	Ditto.
86	Upland Georgian and Buri Kapas. Leaflet.	Ditto	Ditto.
87	Dry Earth Method of Conserving urine. Leaflet.	Ditto	Ditto.
88	*Agricultural Gazette.* A monthly publication. Price, 2 annas per copy.	Ditto	Ditto.
89	Hints to Superintendents of Experiment Stations.	Ditto	Secretariat Press, Nagpur.
90	Report on the Department of Agriculture, Central Provinces, 1906-07. Price, Re. 1.	Department of Agriculture, Central Provinces.	Ditto.
91	Report on the Agricultural Stations in the Central Provinces, 1906-07. Price, Re. 1.	Ditto	Ditto.
92	Report on the Provincial and District Gardens in the Central Provinces, 1906-07. Price, Re. 1.	Ditto	Ditto.
93	Wheat grown in the Central Provinces. Bulletin. Price, Re. 1.	G. Evans, B.A., B.SC., Deputy Director of Agriculture, Central Provinces.	Ditto.
94	A few simple Agricultural improvements. Bulletin No. 16 of 1907.	Rai Bahadur B. C. Basu, M.R.A.C., Asst. Director of Agriculture, E. B. & Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
95	Jhum cultivation in Lumding. Bulletin No. 18 of 1908.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
96	Coffee cultivation in the Khasi hills. Bulletin No. 20 of 1908.	Rai Bahadur B. C. Basu, M.R.A.C., Asst. Director of Agriculture, E. B. & Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
97	Jute cultivation. Leaflet No. 1 of 1907.	Robert S. Finlow, B.Sc., Fibre Expert to the Government of E. B. & Assam.	Ditto.*
98	Jute in rotation with paddy in the same year and its effect on food crops. Leaflet.	S. G. Hart, I.C.S., Director of Agriculture, E. B. & Assam.	Ditto.
99	Annual Report of the Department of Agriculture, E. B. and Assam, for 1906-07. Price, 8 annas.	Department of Agriculture, E. B. & Assam.	Ditto.
100	Annual Report on the Agricultural stations in Eastern Bengal and Assam for 1906-07. Price, 12 annas.	Ditto	Ditto.
101	Annual Report of the Tropical Plantation at Wahjain for the year ending 30th June 1907. Price, 2 annas.	Ditto	Ditto.
102	Annual Report of the Rajshahi Agricultural Station for 1906-07. Price, 2 annas.	Ditto	Ditto
103	Annual Report of the Rangpur Agricultural Station for 1906-07. Price, 2 annas.	Ditto	Ditto.
104	Annual Report of the Jorhat Agricultural Station for 1906-07. Price, 2 annas.	Ditto	Ditto.
105	Annual Report of the Upper Shillong Agricultural Station for 1906-07. Price, 2 annas.	Ditto	Ditto.
106	Annual Report of the Shillong Fruit Garden for 1906-07. Price, 2 annas.	Ditto	Ditto.
107	Wheat cultivation. Leaflet No. 1.	Department of Agriculture, Burma.	Government Press, Burma Rangoon.
108	Farmyard Manure, Dung or cattle manure. Leaflet No. 3.	Ditto	Ditto.
109	The cultivation of Groundnut. Leaflet No. 4.	Ditto	Ditto.

* With Bengali and Assamese translations.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
110	Annual Report of the Department of Agriculture, Burma, for the year ending 30th June 1907.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
111	Introduction of Moulmein paddy into the Akyab district. Leaflet No. 6.	Ditto	Ditto.
112	Annual Report of the Board of Scientific Advice for the year 1906-07. Price, Re. 1.	Board of Scientific Advice, Calcutta.	Government Printing, India, Calcutta.
113	*Agricultural Journal of India*, Vol. III, Part IV. Price, Rs. 2. Annual subscription Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
114	*Agricultural Journal of India*, Vol. IV, Part I. Price, Rs. 2. Annual subscription Rs. 6.	Ditto	Ditto.
115	Seed Time and Harvest Time of Crops grown in Bengal. (Not for sale.)	Department of Agriculture, Bengal.	Department of Agriculture, Bengal.
116	Flax in Behar. Departmental Records No. 1 of 1908. (Not for sale.)	Ditto	Ditto.
117	Annual Report of the Bengal Agricultural Department for the year ending 30th June 1908. Price, 8 annas.	Ditto	Bengal Secretariat Book Depôt, Calcutta.
118	Annual Report of the Cuttack Agricultural Station for the year 1907-08. Price, 4 annas.	Ditto	Ditto.
119	Annual Report of the Dumraon Agricultural Station for the year 1907-08. Price, 4 annas.	Ditto	Ditto.
120	Annual Report of the Burdwan Agricultural Station for the year 1907-08. Price, 4 annas.	Ditto	Ditto.
121	Annual Report of the Tassar Silk Rearing Station, Chaibassa, Bengal, for the year 1907-08. Price, 4 annas.	Ditto	Ditto.
122	*Quarterly Journal* of the Agricultural Department of Bengal, Vol. II, No. 1. Price, 8 annas per copy with postage.	Ditto	Ditto.
123	*Quarterly Journal* of the Agricultural Department of Bengal, Vol. II, No. 2. Price, 8 annas per copy with postage.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
124	Implements, Manure and Seeds. Departmental Record No. 2 of 1908. (Not for sale.)	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
125	Simple Notes on Common Cattle Diseases of Bengal. Leaflet No. 6 of 1908.	D. Quinlan, M.R.C.V.S., Superintendent, Civil Veterinary Department, Bengal.	Ditto.
126	Agricultural Statistics of Bengal for 1907-08. Price, 8 annas.	Department of Agriculture, Bengal.	Ditto.
127	Area and Yield of certain Principal Crops in India for the various periods from 1893-94 to 1907-08. Price, 5 annas.	Commercial Intelligence Department, India.	Government Printing, India, Calcutta.
128	Report of the Indigo Research Station, Sirsiah, for the year 1908-09.	Cyril Bergtheil, Imperial Bacteriologist.	Behar Planters' Association, Mozufferpore.
129	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1908. Price, 8 annas.	Department of Land Records and Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
130	Annual Report on the Cawnpore Agricultural Station for the year ending 30th June 1908. Price, Re. 1.	Ditto	Ditto.
131	Annual Report on the Jalaun (Orai) Agricultural Station for the year ending 30th June 1908. Price, 8 annas.	Ditto	Ditto.
132	Note on the Demonstration and Experimental factories worked during the Sugar Season 1907-08.	Khan Bahadur Saiyid Mohomed Hadi, M.R.A.C., M.R.A.S., Assistant Director, Land Records and Agricultural Department, United Provinces.	London Printing Press, Lucknow.
133	American Cotton and the Method of its Sowing (in Urdu and Hindi). Leaflet.	Department of Land Records and Agriculture, United Provinces.	Newal Kishore Press, Lucknow.
134	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1908. Price, 3 annas.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press, Lahore.
135	Annual Report of the Lyallpur Agricultural Station for 1907-08. Price, 5 annas.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
136	Annual Report of the Department of Agriculture of the Bombay Presidency for the year 1907-08. Price, 5 annas	Department of Agriculture, Bombay.	Government Central Press, Bombay.
137	Annual Report on the Experimental work of the Surat Agricultural Station for the year 1907-08. Price, 14 annas.	Ditto	Ditto.
138	Annual Report on the Experimental Work of the Dharwar Agricultural Station for the year 1907-08. Price, 12 annas.	Ditto	Ditto.
139	Annual Report on the Ganeskhind Botanical Station. Price, 5 annas.	Ditto	Ditto.
140	Annual Report on the Bassein Botanical and Agricultural Station. Price, 4 annas.	Ditto	Ditto.
141	Annual Report on the Experimental work of the Dhulia Agricultural Station for the year 1907-08.	Ditto	Ditto.
142	Season and Crop Report of the Bombay Presidency for 1907-08. Price, 7 annas.	Ditto	Ditto.
143	Field, Orchard and Garden Crops of the Bombay Presidency. Bulletin No. 30 of 1908. Price, 12 annas.	G. A. Gammie, F.L.S., Economic Botanist to the Government of Bombay.	Ditto.
144	Establishment and Management of the Dairy Farm. Bulletin No. 31 of 1908. Price, 3 annas.	G. K. Kelkar, Assistant Professor of Agriculture, Poona.	Ditto.
145	Annual Report of the Experimental Work of the Nadiad Agricultural Station for the year 1907-08. Price, 6 annas.	Department of Agriculture, Bombay.	Ditto.
146	Annual Report on the Experimental Work of the Muvalia Agricultural Station for the year 1907-08.	Ditto	Ditto.
147	Annual Report on the Experimental Work of the Mirpurkhas Agricultural Station for the year 1907-08. Price, 8 annas.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
148	Annual Report on the Experimental Work of the Daulatpur Reclamation Station for the year 1907-08. Price, 3 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
149	Annual Report on the Experimental Work of the Manjri and Lonavala Agricultural Stations for the year 1907-08. Price, 5 annas.	Ditto	Ditto.
150	Annual Report on the Experimental Work of the Kirkee Civil Dairy Farm for the year 1907-08. Price, 4 annas.	Ditto	Ditto.
151	Annual Report on the Experimental Work of the Agricultural College Station, Poona, for the year 1907-08. Price, 4 annas.	Ditto	Ditto.
152	Report of the Operations of the Department of Agriculture, Madras, 1907-08. Price, 6 annas.	Department of Agriculture, Madras.	Government Press, Madras.
153	Scientific Report of the Hagari Agricultural Station for the year 1907-08. Price, 2 annas.	Ditto	Ditto.
154	Scientific Report of the Bellary Agricultural Station for the year 1907-08. Price, 2 annas 3 pies.	Ditto	Ditto.
155	Scientific Report of the Palur Agricultural Station for the year 1907-08. Price, 8 annas.	Ditto	Ditto.
156	Scientific Report of the Samalkota Agricultural Station for the year 1907-08. Price, 3 annas.	Ditto	Ditto.
157	Scientific Report of the Nandyal Agricultural Station for the year 1907-08. Price, 1 anna 6 pies.	Ditto	Ditto.
158	Scientific Report of the Talipa-ramba Agricultural Station for the year 1907-08. Price, 6 annas.	Ditto	Ditto.
159	Scientific Report of the Koilpatti Agricultural Station for the year 1907-08.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
160	Sann-hemp (*Crotalaria juncea*). Bulletin No. 59. Price, 1 anna.	Rao Bahadur C. K. Subba Rao, B.A.	Government Press, Madras.
161	Agricultural Calendar for 1909. (In English, Tamil and Telegu.) Price, 1 anna.	Department of Agriculture, Madras.	Ditto.
162	Report on the Working of the Department of Agriculture, C. P., for the year 1907-08. Price, Re. 1.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
163	Report on the Agricultural Stations in the Central Provinces for the year 1907-08. Price, Re. 1.	Ditto	Ditto.
164	Report on the Management of the Provincial and District Gardens in the Central Provinces for the year 1907-08. Price, Re. 1.	Ditto	Ditto.
165	How to Apply Nitrate of Soda as a Manure for Cotton.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	*Dessewak* Press, Nagpur.
166	Varieties of Potatoes grown in the Central Provinces. Bulletin. Price, Re. 1.	G. Evans, B.A. (Cantab.), Deputy Director of Agriculture, Northern Circle, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
167	*Agricultural Gazette*, a monthly publication. Price, 2 annas per copy.	D. Clouston, M.A., B.Sc. Deputy Director of Agriculture, Central Provinces.	*Dessewak* Press, Nagpur.
168	Annual Report of the Dacca Agricultural Station for the year ending 30th June 1908. Price, 2 annas.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
169	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1908. Price, 2 annas.	Ditto	Ditto.
170	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1908. Price, 2 annas.	Ditto	Ditto.
171	Annual Report on the Tropical Plantation at Wahjain for the year ending 30th June 1908. Price, 2 annas.	Ditto	Ditto.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
172	Annual Report of the Rangpur Agricultural Station for the year ending 30th June 1908.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Shillong.
173	Annual Report of the Shillong Fruit Garden for the year ending 30th June 1908.	Ditto	Ditto.
174	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June 1908.	Ditto	Ditto.
175	Potato Cultivation. Bulletin No. 21 of the Eastern Bengal and Assam Department of Agriculture.* Price, 1 anna.	Ditto	Ditto.
176	How to Water Fruit Trees. Leaflet No. 2.	Ditto	Ditto.
177	Central Seed Depôt, Dacca. Leaflet No. 3.	Ditto	Ditto.
178	Report on the Operations of the Department of Agriculture, Eastern Bengal and Assam, during the year ending the 30th June 1908.	Ditto	Ditto.
179	Cultivation of English Vegetables, Cabbage, Cauliflower and Lettuce. Cultivators' Leaflet No. 7.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
180	Turnip and Khat Rabi or Knol Khol. Cultivators' Leaflet No. 8.	Ditto	Ditto.
181	Carrot, Radish, Beet and Parsnip. Cultivators' Leaflet No. 9.	Ditto	Ditto.
182	Peas, Broad Beans and French Beans. Cultivators' Leaflet No. 10.	Ditto	Ditto.
183	Onions and Leeks. Cultivators' Leaflet No. 11.	Ditto	Ditto.
184	Tobacco Cultivation. Cultivators' Leaflet No. 12.	Ditto	Ditto.
185	Cultivation of Maize. Cultivators' Leaflet No. 13.	Ditto	Ditto.
186	Cultivation of Cotton. Cultivators' Leaflet No. 14.	Ditto	Ditto.

* With Bengali and Assamese translations.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
187	Cultivation of Jute. Cultivators' Leaflet No. 15.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
188	Report on the Operations of the Department of Agriculture, Burma, 1907-08. Price, 4 annas.	Ditto	Ditto.
189	*Agricultural Journal of India*, Vol. IV, Parts I and II. Price, Rs. 2 per part. Annual subscription Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
190	*Quarterly Journal*, Vol. II, Nos. 3 and 4. Price, 8 annas a copy including postage.	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
191	Maize. Leaflet No. 1 of 1909	F. Smith, B.SC., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
192	Juar and Fodder crops in Bengal. Leaflet No. 2 of 1909.	Ditto	Ditto.
193	Sugarcane and Sugarcane experiments in Bengal. Leaflet No. 4 of 1909.	Ditto	Ditto.
194	Aus, Bhadoi, early or summer paddy (rice). Leaflet No. 5 of 1909.	Ditto	Ditto.
195	Note on the soils of Bengal	D. N. Mukerjee. M.A., M.R.A.C., M.R.A.S.	Bengal Secretariat Press, Calcutta.
196	Season and Crop Report of Bengal. Price, 8 annas.	Department of Agriculture, Bengal.	Ditto.
197	Annual Report of the Aligarh Agricultural Station for the year ending 30th June 1908. Price, 8 annas.	Department of Land-Records and Agriculture, United Provinces.	Government Press, Allahabad.
198	Groundnut and the method of its cultivation. Pamphlet in Urdu and Hindi.	Ditto	Newal Kishore Press, Lucknow.
199	List of Improved Agricultural Implements recommended by the Department of Agriculture, Punjab. Bulletin No. 1 of 1909.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press.
200	Cultivation of Broach Cotton in Dharwar. Bulletin No. 33 of 1909. Price, 4 annas or 5*d*.	N. L. Kulkarni, Divisional Inspector, S.D.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
201	Cattle of Southern India. Agriculture Bulletin No. 60. Price, Rs. 2.	Lt.-Col. W. D. Gunn .	Government Press, Madras.
202	Banku Paddy. Note in English and Tamil.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Madras.	Ditto.
203	Report on the Working of the Civil Veterinary Department, Central Provinces, for the year ending 31st March 1909. Price, Re. 1 per copy.	Department of Agriculture, Central Provinces.	Secretariat Press, Nagpur.
204	Leaflet on Ransome's Turnwrest plough in English, Hindi and Marathi.	Ditto	Ditto.
205	Leaflet on Buri Cotton in English, Hindi and Marathi.	Ditto	Ditto.
206	Leaflet on the Cultivation of Groundnut in Marathi and Hindi.	Ditto	Ditto.
207	Pamphlet on more deadly forms of cattle diseases in Marathi. Price, 4 annas a copy.	Ditto	Ditto.
208	*Agricultural Gazette* monthly from February to July 1909. Price, 2 annas a copy.	Ditto	*Dessewak* Press, Nagpur.
209	The Principal Fatal Diseases of Cattle. Veterinary Leaflet No. 1 of 1909 in English, Bengali, Assamese and Khasi.	W. Harris, Superintendent, Civil Veterinary Department, Eastern Bengal and Assam.	Secretariat Press, Shillong.
210	Precautions necessary to prevent the spread of Contagious Diseases. Veterinary Leaflet No. 2 in English, Bengali, Assamese and Khasi.	Ditto	Ditto.
211	Foot and Mouth Disease. Veterinary Leaflet No. 4 in English, Bengalee, Assamese and Khasi.	Ditto	Ditto.
212	The use of Small Bullock hoe. Cultivators' Leaflet No. 16.	Department of Agriculture, Burma.	Government Press, Rangoon.
213	Climatological Tables for Burma.	F. J. Warth, M.Sc., Agricultural Chemist, Burma.	Ditto.
214	Heeleaka Experimental Station.	C. M. Hutchinson, B.A.	Indian Tea Association.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	Agricultural Chemistry.		
1	The Loss of Water from soil during dry weather. Memoirs of the Department of Agriculture, Vol. I, No. 6. Price, Rs. 2.	J. Walter Leather, Ph. D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
2	Official and Recommended Methods for use in Chemical Laboratories of the Departments of Agriculture in India. Bulletin No. 8 of the Agricultural Research Institute, Pusa. Price, 4 annas.	Ditto	Government Printing, India, Calcutta.
3	Annual Report of the Laboratory Work of the Agricultural Chemist of the Bombay Presidency. Price, 4 annas.	Department of Agriculture, Bombay	Government Central Press, Bombay.
4	Report to the Government of India containing an account of the Research Work on Indigo performed in the University of Leeds, 1905-07. Price, 3 shillings.	W. Popplewell Bloxam, B.Sc. (Lond.), F.C.S., F.I.C.	Published by order of His Majesty's Secretary of State for India in Council.
5	Report of Experiments to test the value of manures for crops in Behar.	J. W. Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa; H. E. Annett, B.Sc., Supernumerary Chemist, Pusa; and W. Roberts, B.Sc., Supernumerary Agriculturist, Pusa.	Behar Planters' Association, Mozufferpore.
6	Sugarcane at the Partabgarh Experiment Station. Bulletin No. 13 of the Agricultural Research Institute, Pusa. Price, 4 annas.	G. Clarke, F.I.C., Agricultural Chemist, United Provinces; and Khan Bahadur S. M. Hadi, M.R.A.C., M.R.A.S., Assistant Director of Agriculture, United Provinces.	Government Printing, India, Calcutta.
7	Annual Report of the Agricultural Chemist to the Government of Mysore for the year 1906-07.	A. Lehmann, M.A., B.S.A., Ph.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
8	The System Water, Calcium Carbonate, Carbolic Acid, Chemical Memoir, Vol. I, No. VII of the Imperial Department of Agriculture. Price, Re. 1.	J. W. Leather, Ph.D., F.I.C., F.C.S., and J. N. Sen, M.A., F.C.S.	Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
		Mycology.	
1	Fungi Indiæ Orientalis, Part II.	E. J. Butler, M.B., F.L.S. (in collaboration with H. Sydow).	Annales Mycologici, Vol. V, No. 6 of 1907.
2	Report on trials of the South African Locust Fungus in India. Bulletin No. 5 of the Agricultural Research Institute, Pusa. Price, 2 annas.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa; and H. Maxwell Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa.	Government Printing, India, Calcutta.
3	Report on Cocoanut Palm Disease in Travancore. Bulletin No. 9 of the Agricultural Research Institute, Pusa. Price, 6 annas.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.	Ditto.
4	Palmyra Palm Disease in Godaveri. Leaflet.	Ditto	Ditto.
5	Cocoanut Palm Disease in Travancore. Leaflet.	Ditto	Ditto.
6	Sugarcane red-rot in Burma. Leaflet.	Ditto	Ditto.
7	Bordeaux Mixture as a preventive of potato disease. Bulletin No. 19.	Rai Bahadur B. C. Basu, M.R.A.C., Assistant Director of Agriculture, E. B. & Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
8	Note on the Orange Blight in the Khasi Hills. Leaflet.	Ditto	Ditto.
9	The Haustorium of Olax Scandens. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. II, No. 4. Price, Rs. 2-8.	C. A. Barber, M.A., F.L.S., D.SC., Government Botanist, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
10	The Haustorium of Cansjera Rheedii. Memoirs of the Department of Agriculture in India. Botanical Series, Vol. II, No. 5. Price, Rs. 2-8.	Ditto	Ditto.
11	On Flax Dodder. Bulletin No. 11 of the Agricultural Research Institute, Pusa. Price, 4 annas.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist.	Government Printing, India, Calcutta.
12	The Mulberry Disease caused by Coryneum Mori Nom in Kashmir with notes on other Mulberry Diseases. Botanical Memoir, Vol. II, No. VIII of the Imperial Department of Agriculture. Price, Re. 1-8.	E. J. Butler, M.B., F.L.S.	Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	Mycology—contd.		
13	Pamphlet on Prevention of Smut, in Urdu and Hindi.	Department of Land Records and Agriculture, United Provinces	Newal Kishore Press, Lucknow.
	Economic Botany.		
1	Immune Wheats. Journal of Agricultural Science, Vol. II, Part III, 1907.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist, Pusa (in collaboration with G. L. C. Howard).	Cambridge University Press, Cambridge, England.
2	Some Difficulties in Sugarcane Experiments. International Sugar Journal, September 1907.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist, Pusa.	Office of "Sugarcane" Altrincham, Manchester.
3	Notes on Agave and Furcræa in India. Bulletin No. 8 of Bengal Department of Agriculture.	J. R. Drummond and D. Prain.	Bengal Secretariat Press, Calcutta.
4	The Indian Cottons. Memoirs of the Department of Agriculture, Vol. II, No. 2. Price, Rs. 7-8.	G. A. Gammie, F.L.S., Economic Botanist to the Government of Bombay.	Messrs. Thacker, Spink & Co.
5	Note on Toxic substance excreted by the roots of plants. Memoirs of the Department of Agriculture, Vol. II, No. 3. Price, Re. 1-8.	F. Fletcher, M.A, B.S.C., Deputy Director of Agriculture.	Messrs. Thacker, Spink & Co., Calcutta.
6	The Making and Care of Lawns in India. Bulletin No. 12 of the Agricultural Research Institute, Pusa. Price, 4 annas.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist.	Government Printing, India, Calcutta.
7	The Milling and Baking qualities of Indian Wheats. Bulletin No. 14 of the Agricultural Research Institute, Pusa. Price, 4 annas.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist; and Gabrielle L. C. Howard, M.A., Associate and late Fellow of Newham College, Cambridge.	Ditto.
8	The Races of Jute, *Agricultural Ledger* No. 6 of 1907. Price, 12 annas.	I. H. Burkill, M.A., Reporter on Economic Products to the Government of India, and R. S. Finlow, B.Sc., Fibre Expert to the Government of Eastern Bengal and Assam.	Government Printing, India, Calcutta

List of Agricultural Publications in India during 1907-09—contd.

No.	Title.	Author.	Where published.
	Economic Botany—contd.		
9	A note on the Preparation and Packing of Specimens of Plants and Insects. Leaflet No. 3 of 1909.	E. J. Woodhouse, B.A., Economic Botanist, Bengal.	Department of Agriculture, Bengal.
10	The Varietal Characters of Indian Wheats. Botanical Memoir, Vol. II, No. VII of the Imperial Department of Agriculture. Price, Re. 1.	A. Howard, M.A.; and G. L. C. Howard, M.A.	Messrs. Thacker, Spink & Co., Calcutta.
11	Some Experiments in the Hybridizing of Indian cottons. Botanical Memoir, Vol. II, No. 6 of the Imperial Department of Agriculture. Price, Re. 1-8.	P. F. Fyson, B.A., F.L.S.	Ditto.
	Entomology.		
1	The Mustard Saw-fly. Memoirs of the Department of Agriculture, Vol. I, No. 6. Price, Re. 1.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa; and C. C. Ghosh, B.A.	Ditto.
2	The Rice Bug. Memoirs of the Department of Agriculture, Vol. II, No. 1. Price, Re. 1.	Ditto	Ditto.
3	Remarks on Indian Scale Insects (Coccidæ), Part III. Memoirs of the Department of Agriculture, Vol. II, No. 2. Price, Re. 1-8.	E. E. Green, F.E.S., F.Z.S., Government Entomologist, Ceylon.	Ditto.
4	The Red Cotton Bug. Memoirs of the Department of Agriculture, Vol. II, No. 3. Price, Rs. 2.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa.	Ditto.
5	The Castor Semi-looper. Memoirs of the Department of Agriculture, Vol. II, No. 4. Price, Rs. 2.	Ditto	Ditto.
6	The Tobacco Caterpillar. Memoirs of the Department of Agriculture in India, Vol. II, No. 5. Price, Re. 1-8.	Ditto	Ditto.
7	The Cotton Leaf Roller. Memoirs of the Department of Agriculture in India, Vol. II, No. 6. Price, Re. 1-8.	Ditto	Ditto.
8	Ticks infesting domesticated animals in India. Bulletin No. 6 of the Agricultural Research Institute, Pusa. Price, 4 annas.	C. Warburton, M.A., Zoologist to the Royal Agricultural Society of England.	Government Printing, India, Calcutta.

List of Agricultural Publications in India during 1907-09—concld.

No.	Title.	Author.	Where published.
	Entomology—contd.		
9	A Preliminary Account of the Biting Flies of India. Bulletin No. 7 of the Agricultural Research Institute, Pusa. Price, Re. 1.	H Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa.	Government Printing, India, Calcutta.
10	Treatment and observation of Crop Pests on the Pusa Farm. Bulletin No. 10 of the Agricultural Research Institute, Pusa. Price, 6 annas.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, Pusa; and C. S. Misra, B.A., Assistant to the Imperial Entomologist, Pusa.	Ditto.
11	Chafers (Po Kyaing Gaung and Chafer Grubs—Po Di. Gaung), Leaflet No. 1.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
12	Annual Report on the Entomological Work conducted in the district during 1907-08. Price, 5 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
13	Locust in India. Bulletin No. 32 of the Bombay Department of Agriculture. Price, 8 annas.	H. M. Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
14	Notes on some Insect Pests. Bulletin No. 17 of the Department of Agriculture, E. B. and Assam. (Revised Edition.) Price, 1 anna.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Government Press, Shillong.
15	Leaflet on the Juar Stemborer, in English, Hindi and Marathi.	Department of Agriculture, Central Provinces.	Secretariat Press, Nagpur.
16	The Palm Beetle or Rhinoceros Beetle. Cultivators' Leaflet No. 17.	Department of Agriculture, Burma.	Secretariat Press, Rangoon.
17	Granary Pests Bulletin No. 1 (*in the press*).	Ditto	Ditto.
18	Rinder pest. Veterinary Leaflet No. 3, in English, Bengali, Assamese and Khasi.	W. Harris, Superintendent, Civil Veterinary Department, Eastern Bengal and Assam.	Secretariat Press, Shillong.
19	Mosquito Blight Report on Experiments during 1908 at Rampur and Koombergram Tea Estates.	C. B. Antram, F.E.S.	Ditto.
20	Mertis Insects Predaceous on the tea mosquito.	Ditto	Ditto.

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REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1909-10

By

BERNARD COVENTRY

Offg. Inspector General of Agriculture in India

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1911

TABLE OF CONTENTS.

	PAGE
Introductory	1
Part I.—Outlines of the work of the Imperial Department of Agriculture	7
1. Office of the Inspector General of Agriculture in India	7
2. Tours	7
3. Agricultural Research Institute, Pusa	8
(*a*) Staff, etc.	8
(*b*) Training	9
(*c*) Agriculture	10
(*d*) Botany	12
(*e*) Agricultural Chemistry	12
(*f*) Mycology	14
(*g*) Entomology	16
(*h*) Agricultural Bacteriology	18
Part II.—Outlines of the Work conducted in the Provinces	19
1. Bombay	19
2. Madras	21
3. Bengal	22
4. United Provinces	23
5. Punjab	24
6. Central Provinces	25
7. Eastern Bengal and Assam	26
8. Burma	27
Part III.—Crops and Special Subjects	28
1. Crops	28
(*a*) Cotton	28
(*i*) Selection and Distribution of Cotton Seed	28
(*ii*) Introduction of Superior Indigenous Varieties and better Methods of Cultivation	30
(*iii*) Hybridisation	31
(*iv*) Trials of Exotic Varieties	32
(*v*) Tree Cottons	35
(*b*) Wheat	35
(*c*) Groundnut	39
(*d*) Sugarcane	42
(*e*) Tobacco	45

PAGE

Part III.—Crops and Special Subjects 28

1. Crops 28
   (*f*) Indigo 48
   (*g*) Jute 49
   (*h*) Flax 50
   (*i*) Other Fibres 53
   (*j*) Tea 56
   (*k*) Cassava 59
   (*l*) Rice 60
2. Artificial Fertilisers 61
3. Distribution of Seeds 65
4. Distribution of Implements 68
5. Irrigation 71
6. Dry-Farming 75
7. Alkali or Reh Lands 76
8. Special Enquiries 78
9. Sericulture 80
10. Poultry-Breeding 84
11. Agricultural Education 85
12. Publications 89
13. Board of Agriculture 91
14. Expenditure 92

Appendix.—List of Agriculture Publications in India during 1909-10 95

REPORT

ON THE

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1909-10.

INTRODUCTORY.

In the preparation of the Report on the Progress of Agriculture in India for the past year, I have made a few slight alterations which I trust may be found an improvement. The report has been divided into three parts: Part I dealing with the Imperial Department of Agriculture, Part II with the Provincial Departments and Part III with Crops and Special Subjects. Instead of the résumé of the provincial reports being relegated to the appendices, I have brought them within the body of the report in order to give them the prominence which is their due. I feel, however, that it has been quite impossible to do full justice to much valuable work which is being carried on in India by the very short references I am constrained to make, and many an important investigation is apt to be lost in the mass of routine operations which have to be recorded. I would, therefore, urge that where interest is taken in any particular subject, further information be sought in the more detailed reports and publications of the departments.

It is gratifying to be able to state that progress has been continuous and satisfactory and especial mention may be made of the following. The improvements in Cotton cultivation are at this moment affecting many thousand acres in the great cotton areas in the presidencies of Bombay and Madras and in the Central Provinces, and the excellent plant-breeding work in cotton which is being done in the United Provinces bids fair to

materially improve the crop in that province. There is no longer any doubt but that India can, as indeed it once did in the past, grow very much finer cotton. But there are difficulties in the way of complete success which are worth considering here owing to the importance at the present moment of the cotton problem. *First*, it has to be remembered that India is essentially the producer of a short staple cotton and that its trade is for short staple. The chief consumers of Indian cotton are India itself, Germany and Japan. In Germany, it is used principally for mixing with wool and thus serves a special purpose. *Secondly*, short staple cottons give a better yield per acre than long staple cottons. *Thirdly*, the climate of India which allows in most cases only of a short period of growth, favours the production of short staple rather than long staple which requires a long period of growth. Therefore, on the whole, it suits India to produce a short staple cotton. Now if we are to induce the cultivator to change his present methods and produce long staple cotton, we have to bear in mind two things, *first*, that the price for the long staple cotton must not only be higher than that for the short staple, but it must be so high that it will cover the loss in yield which must inevitably occur in changing from a short to a long staple; and *secondly*, we have to recognise that the existing foreign trade and market would have to be entirely shifted from Germany and Japan to England, for there are no buyers of long staple cotton in India at present. Neither the Government nor the agricultural department can do either of these two things. It is for the trade itself to move in the matter. The cultivator has produced and can produce finer cotton and the agricultural department is successfully showing him how to do this. There are, moreover, large tracts in Sind and the Punjab where American and Egyptian cottons do extremely well. What, however, has been found the most serious obstacle in the way of progress is that there being no buyers of long staple cotton in India, the grower does not get full value for his produce with the result that though the price paid may be higher than for the coarser, the net result is often against the cultivator owing to the lower yield. At the same time, it is known that if full value were paid for the longer staple, or in other words, if there were

a market for long staple cotton in India, which there is not, the cultivator in many cases would undoubtedly benefit more by growing it in spite of the lower yield. The only possible solution of this difficulty is in the creation in India of a buying agency to buy, gin, bale and export long staple cotton. Until this is done, the valuable work of the department must remain more or less at a standstill. Perhaps the British Cotton Growing Association may see their way to move in the matter.

The improvement by selection and hybridisation which has been done on wheat deserves special mention. It has been proved that India can grow not only stronger wheats with better milling qualities than those now exported, but there are many wheats which it has been found possible to class with American and Canadian wheats which command the highest prices in the English market. Some new hybrids have also been raised which from point of quality and yield promise to equal if not surpass those already in existence. These wheats have been subjected to tests which include the grinding of the wheat into flour and the baking from it of bread. Experts both in India and in England are unanimous in their opinions that they are far finer than anything which is now being exported and millers at home have declared their eagerness to purchase them. These facts should sooner or later have a profound effect on the export trade.

The reclamation of the salt lands of Sind is work which is of prime importance to that province. There are large areas of this class of land which have been infertile probably for centuries and yet at a very moderate cost, it has been demonstrated over an area of 400 acres that it is possible to so reclaim the land that full crops can be grown the year after treatment. The methods used in Sind are perhaps not applicable to all classes of salt lands, but there is no doubt but that there are very large areas which can be treated by this process.

The campaign against the palm disease in the Godavery delta which has been mentioned in previous reports is being vigorously continued and is the cause of lakhs of rupees per annum being saved to the palm industry. The new and better canes which have been recently introduced into parts of the Madras presidency are bringing considerable profit to the cultivators which

more than equals the cost of the local department of agriculture. Improved implements and labour saving machinery have been successfully introduced in the Central Provinces, Bombay presidency, the Punjab and the United Provinces, and are without any doubt of great benefit to the cultivator. These are but a few examples of successful work which has been achieved or is being pushed by the agricultural department, and which, if space permitted, might be increased. It is now only six years since the department commenced its work on modern lines under the organisation created by Lord Curzon. From that time, a great deal of spade work has had to be performed, a staff has had to be recruited from Europe, which has had to make itself acquainted as fast as possible with Indian conditions. Indian Assistants have had to be selected and trained to aid the Scientists in their work of research: and yet in spite of the initial work and difficulties of the kind described, in spite of the slowness of experimentation inherent in agricultural work which is limited in progress by the seasons, and in spite of the hoary conservatism of the peasant class, the performance of the department within that short period is not only more than sufficient to justify its existence, but indeed owing to the great value of the subjects with which it deals, calls for further help towards expansion. The experience so far gained shows that the present staff is quite inadequate to cope with the growing needs of the department and the urgent problems which are presenting themselves for solution. In most provinces, the need of more agriculturists is keenly felt, as well as the want of agricultural engineers, and there are instances where the agricultural public is clamouring for an extension of the work of the department, a demand which has to remain unsatisfied for want of staff. The need too which exists for men to fill posts which become vacant when officers take leave is also being keenly felt and work in hand set back in consequence, but as the creation of a leave reserve is engaging the attention of Government this want will doubtless be soon satisfied.

The progress in agricultural education has been somewhat slower than that in investigation and research. This was bound to be the case owing to the fact that colleges and quarters for

students have had to be built and sites acquired and a subordinate staff to each collected and specially trained for the work. There are now six agricultural colleges in working order in the provinces, namely, Bombay, Madras, Bengal, Central Provinces, United Provinces, and the Punjab. The purpose of these colleges is to take young men who have passed the Matriculation or other equivalent examination through a three years' course in general scientific and practical agriculture up to the degree of L. Ag. The most successful of these students will then proceed to the Central Research Institute at Pusa, there to complete another two years' post-graduate course in specialising which is intended to fit them to perform the duties of assistant to the expert officers or to become expert officers themselves. The number of students for so high a training will of necessity be comparatively few, but in any case it will depend upon the number which the provincial colleges will turn out as sufficiently fit or qualified to go through this higher training. During the past few years, Pusa has been training the men who have been specially selected to fill the posts in the subordinate staff in the provinces and now it must await the result of the three years' course which is being given in the provincial colleges before a regular flow of students for higher training can be expected. Until then, the number of students admitted to Pusa must remain limited.

While on this question of agricultural education, it is not out of place to point out the want which exists for agricultural schools. It will doubtless be conceded that if the work of our colleges and research institutes is to have the full effect it is desired upon the agriculture of the country, it is necessary that there should be a corresponding effort made to teach the agricultural classes the principles of agriculture by the creation of agricultural schools. An intelligent and well-informed body of agriculturists appears to be as necessary as a highly trained body of teachers; one indeed is the complement of the other. If this principle is accepted the creation of agricultural schools must form an integral part of the organisation for the improvement of agriculture. That the want of such schools is being felt is exemplified in the attempts

that are being made by some of the agricultural departments, notably in Bombay, to run agricultural schools. How far it is the duty of the agricultural department to do this work or whether it could not be better performed by the Education Department is a matter for consideration. It is certain that the Education Department could very greatly help in the solution of the problem. The introduction into the primary schools of the methods of Nature study would go a long way towards bringing to the mind of the young cultivator a habit of closer observation of the things around him and make him more receptive of the teachings of the principles underlying his profession. If this be followed by the teaching of agriculture in agricultural schools in rural areas the gap in the scheme of agricultural education which now exists would be filled up. Not only would the agricultural classes more rapidly and intelligently absorb the teachings of the higher institutions, but material of a kind which does not at this moment exist would be formed for manning our colleges and institutes. It would seem that the present is an opportune moment for the Agricultural and Educational Departments to come together and consider how agricultural education could best be imparted to the agricultural classes.

I have to thank Mr. A. McKerral, Assistant Inspector-General of Agriculture, for the material assistance he has given me in the preparation of this report.

PUSA,

The 9th January 1911.

Part I.

Outlines of the work of the Imperial Department of Agriculture.

1. *Office of the Inspector General of Agriculture in India.*—The post of the Inspector General of Agriculture in India was held by Mr. J. Mollison, M.R.A.C., until 5th May 1910, when he proceeded on two years' leave and I was appointed to officiate for him. The post of Assistant Inspector General of Agriculture was filled by Mr. E. Shearer, M.A., B.Sc., till 3rd November 1909, when he proceeded home on 6 months' special leave on urgent private affairs. On account of ill-health, Mr. Shearer was constrained later to resign his appointment in the Indian Agricultural Service with effect from the 4th May 1910. Mr. Shearer's resignation has been a loss to the Department. Mr. A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Burma, was appointed Assistant Inspector General of Agriculture in Mr. Shearer's place. He took over charge of his duties on 19th June 1910. For a time he was placed under the Director of the Agricultural Research Institute, Pusa, to assist in the work of the Pusa Farm and also to supervise the cattle, sheep and poultry-breeding. The head-quarters of the Inspector-General of Agriculture were transferred from Nagpur to Pusa on 1st July 1910.

2. *Tours.*—During the year under report, my predecessor, Mr. Mollison, toured twice in the Bombay presidency, the Central Provinces, the Punjab, and once in Sind and the United Provinces of Agra and Oudh. He camped at Pusa several times during the year under review. He was also with the Government of India at Calcutta and Simla for short periods for consultation on important matters.

The Bombay Agricultural Conference was held at Poona on 29th and 30th September 1909, and was attended by Mr. Mollison. Almost all the farms in the Bombay presidency were inspected and advice was given on the teaching at the Agricultural College, Poona. Experiments with *kalar* land, towards which the Imperial Department of Agriculture has contributed a sum of Rs. 3,100 for the current year, and general work on

experiment stations in Sind were inspected by Mr. Mollison in company with Mr. Henderson.

In the Central Provinces, the district demonstration work which has been so successful there, was inspected in company with Messrs. Clouston and Evans. The teaching at the Agricultural College at Nagpur and work at the Telinkheri Cattle Farm and other experiment stations in the Central Provinces were examined and suggestions made to the local officers.

Mr. Mollison visited the Punjab Industrial and Agricultural Exhibition held at Lahore in December 1909, and the Agricultural College at Lyallpur and assisted the agricultural department in the selection of a suitable site for the farm at Gurdaspur. He included in the same tour other places of agricultural interest, such as Amritsar, Saharanpur, and Amballa.

In the United Provinces, Mr. Mollison attended the district agricultural exhibition held at Allahabad during January 1910. From Allahabad he went to Bhadan where he saw the investigations that are being carried out in connection with *Usar* lands. The work at the experimental stations of Aligarh and Cawnpore was also inspected as well as the Agricultural College at Cawnpore.

At Pusa, Mr. Mollison presided over the 6th meeting of the Board of Agriculture which was held in February 1910, and much of his time was also spent in inspecting and aiding the research and experimental work in progress.

3. *Agricultural Research Institute.*

(*a*) *Staff, etc.*—I held charge of the office of Director up to the 9th May 1910, with the exception of one month in September—October 1909, when I was on privilege leave and Mr. H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, acted as Director in addition to his own duties. In consequence of my appointment as officiating Inspector General of Agriculture in India, I relinquished charge of the office of Director on the 9th May 1910, and Dr. E. J. Butler, M.B., F.L.S., Imperial Mycologist, was appointed to officiate as Director in addition to his own duties. On the return of Dr. Leather, Ph.D., F.I.C., F.C.S., from leave, Mr. H. E. Annett, B.Sc., M.S.E.A.C., Supernumerary Agricultural Chemist, who was officiating for him,

was deputed to act as Agricultural Chemist in the United Provinces. On relief by Dr. Butler, Mr. W. Mc.Rae, M.A., B.Sc., who was officiating Imperial Mycologist during Dr. Butler's absence from 1st April 1909 to 26th December 1909, joined his new appointment of Mycologist to the Government of Madras. Mr. C. M. Hutchinson, B.A., formerly Scientific Officer to the Indian Tea Association, joined this Institute as Imperial Agricultural Bacteriologist on 27th December 1909.

During the year under report, the posts of First Assistant to the Imperial Agricultural Chemist, Imperial Mycologist, Imperial Economic Botanist, Imperial Entomologist, Imperial Agricultural Bacteriologist, the Veterinary Overseer at Pusa and the Second and Third Assistants to the Imperial Agricultural Chemist have been admitted to gazetted rank.

(*b*) *Training.*—The post-graduate courses in Agriculture, Economic Botany, Agricultural Chemistry, Mycology and Entomology have been continued. It is hoped that when the provincial agricultural colleges have begun to turn out a regular flow of qualified students, an increasing number will take advantage of the special facilities available at Pusa for higher training. Out of the students admitted in the previous year 9 continued their course and of these 7 left during the year after the completion of their training and one was recalled to his province before the expiry of his term. Four new students were admitted during the year; one in Chemistry (an Assistant to the Agricultural Chemist, United Provinces) for a three months' course, one in Mycology (a private student from Bombay), one in Entomology from the Central Provinces Department of Agriculture, and one for a general course in Agriculture from the Punjab Department of Agriculture. The private student from Bombay, however, abandoned the course and left the Institute. There were at the end of the year four students under training, *viz.*, one in chemistry, two in entomology and one for a general course.

The short courses inaugurated last year have been continued. They have been instituted to afford practical instruction in various branches of agricultural work to students from the provinces, who are *bonâ fide* cultivators or land-holdeos. The

instruction which they afford will subsequently be given at the local colleges but it was considered that at the present stage of the development of these colleges much timely help could be given by an institution like Pusa where full facilities for such instruction were already in existence. Much importance was placed on these courses by my predecessor and their growing popularity points to their filling a much felt want. The number of students admitted to these short courses was as follows :—

6 Fruit-growing.
18 Eri Silk Culture.
10 Lac Culture.
9 Cattle-breeding and Management.
3 Poultry-keeping.
3 Tillage Implements and Agricultural Machinery.

(*c*) *Agriculture.*—Mr. E. Shearer, M.A., B.Sc., Imperial Agriculturist, relinquished charge of the farm on the 16th July 1909, on his appointment to the post of Assistant Inspector General of Agriculture in India and the work of the farm was at first carried on by the Director in addition to his own duties. Since the appointment of the Director as officiating Inspector General of Agriculture, the duties of the farm were entrusted to Mr. A. McKerral, M.A., B.Sc., Assistant Inspector General of Agriculture in India, who has been assisted by Mr. G. Sherrard, B.A., Assistant Agriculturist.

The permanent manurial and rotation experiments and the permanent pasture experiments have been continued according to the scheme described in the Proceedings of the Board of Agriculture, 1908. Sufficient time has not elapsed for making deductions from their results.

The trials with many varieties of sugarcane were continued as in previous years. In spite, however, of the care and control with which the cultivation and selection of this crop was carried out, the results have been entirely disappointing. It has been realised that the locality is unsuited to the growth of thick canes such as were being cultivated, and with the exception of a small area reserved for the Mycologist and Entomologist for their experiments, the cultivation of this crop at Pusa has been given up.

The experimental cultivation of flax has been continued. The prospects of this crop in certain parts of India appear promising, provided it is grown in the best possible way, that is to say, in strong land with an abundance of moisture. The experiments which are now in progress should remove many of the doubts and difficulties which have prevented this crop being more generally cultivated.

Perhaps amongst the most useful work carried out on the farm is that of the preservation of fodder. In a country like India where cattle food supplies are subject to vicissitudes of an uncertain climate, this subject is of the highest interest. The production of ensilage on the American principles has been found the most satisfactory method of preservation. Maize was found to give the most nutritious food when thus prepared but in point of yield per acre sorghum gave more weight and is therefore more economical. An objection to the American system of making ensilage in this country is the expense of constructing the silo. Experiments are, however, in progress with a view to devising a cheap indigenous pattern which, if successful, will not only enable the better class of cultivator to adopt siloing, but will be of use perhaps to Government Departments in the preservation of fodder against famine years. I may draw attention to an illustrated article on the "Bamboo Wattle Silo" which has appeared in the issue of the *Agricultural Journal of India* for January 1911.

As regards Cattle-breeding, the Montgomery herd of cows continues to do well at Pusa, the flock of 80 Bikanir sheep, however, have done badly. The change from an excessively arid to a humid tract caused a break-down in their constitution with the result that most of them died. They have been replaced by a flock of Gorakhpur ewes which are good specimens of the local breed and which are expected to do better. They will be crossed with Dumba rams to improve them for mutton and wool purposes. Poultry-breeding is now being conducted on a fairly large scale. The varieties of fowls which at present have done best are the Partridge Wyandotte, White Wyandotte, White Orpington and Barred Plymouth rocks. The Mammoth Bronze Turkeys have also done well. Further details are given in the section on poultry-breeding below.

(*d*) *Botany.*—Mr. A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., continued to be in charge of the section of Economic Botany at Pusa up to the 30th April 1910, when he went on privilege leave. During his absence the routine work was entrusted to his Assistant, Mr. Abdur Rahman Khan.

The work of this section must always be of prime importance to Indian agriculture. By the introduction of a better plant, it is easily possible to increase yield and improve quality without adding to the cost of cultivation. The wheats bred by Mr. Howard which were sent home last year for testing have been found to rank in the same class as the American and Canadian Spring wheats which command the highest price in the English market. These facts are likely to exert in the future a profound effect upon the export wheat trade of India. More detailed information will be found in the paragraph on wheat below and the recent publications on wheat by Mr. and Mrs. Howard.

Mr. Howard has continued his work on fruit culture. The more recent results have been published in Pusa Bulletin No. 16. Sanction of the Secretary of State for India has been obtained to the proposals for fruit culture in Baluchistan where the conditions and climate are considered extremely suitable for exploiting a fruit trade. This work will be undertaken by Mr. and Mrs. Howard during the months April to September for the next three years. The botanical characteristics of most of the Indian tobaccos have been recorded in two Memoirs, while on the practical side some preliminary curing experiments for the production of cigarette tobacco have been made in conjunction with the Peninsular Tobacco Company of Monghyr. Mr. and Mrs. Howard have also published a Memoir on *Sann* (*Crotalaria juncea*) in which the beneficial effect of this crop as a green manure for tobacco and other crops is described. A Memoir on the occurrence of natural cross-fertilisation in India is being published in which the significance of this fact, both from the point of view of plant-breeding and from that of seed distribution, is emphasised.

(*e*) *Agricultural Chemistry.*—Mr. H. E. Annett, B.Sc., Supernumerary Agricultural Chemist, was in charge of this section until 27th October 1909, when Dr. Leather returned from leave.

The principal work undertaken by this department during the past year has been the study of soil gases in relation to other constituents in the soil, the examination into the nature of *Usar* land of the black alkali type and the investigations into the water requirements of crops. The first part of the work in connection with soil gases has been published as Memoir No. 7, Chemical Series, and a further Memoir on the same subject is in the course of preparation. The study of *Usar* has been taken up in conjunction with the agricultural department of the United Provinces where the sterility of *Usar* land and the means of overcoming it, forms an important problem. Special attention may be invited to Dr. Leather's work on the water requirements of crops. In India, where water is the prime factor underlying the successful growth of crops, its conservation and economical use are naturally of first rate importance. These remarks apply with equal force whether the water is derived from the monsoon rainfall or the irrigation canal. How much water is transpired by various crops and during what period of growth the crop requires the principal portion of this water are questions of as great importance to the agriculturist as to the Irrigation Engineer. In Chapter XI of the Report of the Indian Irrigation Commission, 1901—03, the Commissioners remarked: "In the course of our investigations, we have been struck with the small amount of attention which appears to have been given by the Departments of Agriculture and Public Works to matters connected with the application of water to cultivated crops. At present, most of the information which can be had on these points has to be taken from papers published by the Agricultural Bureau in America. . . . . We consider it extremely desirable that expert enquiry should be directed to these important matters, which are so intimately connected with the development of irrigation." This enquiry Dr. Leather has undertaken and in Memoir No. 8, Chemical Series, he has published the results of his work on the first section of the investigation, *viz.*, that which deals with the total amount of water transpired by the crop and the period of growth during which the greater part is assimilated. The ratio between the amount of water transpired and the ultimate weight of the dry crop is

worked out for most of the principal Indian crops. During the year Mr. Annett, Supernumerary Agricultural Chemist, published an interesting Memoir giving an explanation of the dark colour of the black cotton soil.

(*f*) *Mycology.*—Mr. W. McRae, M.A., B.Sc., Supernumerary Mycologist, held charge of the section until 27th December 1909, when Dr. Butler, M.B., F.L.S., returned from leave. Mr. McRae joined his appointment as Mycologist to the Government of Madras immediately after. His successor, Mr. F. J. F. Shaw, B.Sc., A.R.C.S., arrived towards the end of January 1910. The Mycological Section at Pusa has continued to meet the requirements of provincial departments. Collections of named fungi, chiefly parasitic, were furnished to the Departments of Agriculture in Madras, Punjab, Bengal and Eastern Bengal and Assam. Duplicate collections made in Bombay and Burma were identified, as far as possible, and the determinations forwarded to these departments. This work will be continued so as to provide a nucleus for a Mycological Herbarium in every provincial agricultural college.

On the side of research, the most important new work undertaken by Mr. McRae, officiating Imperial Mycologist, was in connection with the blister blight of tea, a disease which appeared for the first time in Darjeeling in 1908 and has since extended into the Dooars and Terai. The results of Mr. McRae's work were communicated to the Darjeeling Planters' Association by whom they have been printed for circulation to the planters concerned. Further details on this subject are given in the section on Tea.

The bud-rot disease of palms in the Godavari delta has not ceased to engage the attention of the Imperial Mycologist, and recommendations have been made for continuing the work of repression, especially in the Kistna district, where, in spite of repeated warnings, it was being neglected. A full account of the disease and measures to check it is in the press and will appear shortly as a memoir.

In November last, Mr. McRae visited the Wynaad at the request of the United Planters' Association of Southern India,

to investigate the pepper vine wilt disease. He was accompanied by Mr. R. D. Anstead, B.A., planting expert to the association, in conjunction with whom a scheme of experiments for the treatment of the disease was drawn up. As the cause and indeed the whole history of this disease are still obscure, little advice of real value to pepper planters could be given. In connection with the wilt of pigeon pea Dr. Butler published the results of several years' work in the early part of 1910.

The work in connection with sugarcane diseases has not yet reached the stage of publication. Field experiments on the methods of infection of red-rot having developed unexpected difficulties, it will be probably necessary to continue the work with pot-cultures. But in the opinion of the Imperial Mycologist there is no doubt that it is primarily a disease conveyed in the sets, and it is encouraging to report that at the Samalkota farm in Madras, where proper precautions were taken in planting, scarcely a trace of it could be found in the last crop. Similarly at Pusa, there is ordinarily little except where the inoculation experiments are in progress. These results are believed to be due almost entirely to the methods of set selection recommended by the Mycological section in 1906.

Among other diseases investigated were the ginger rot and the diseases of the citrus and papaya fruits. An illustrated account of the ginger rot with suggestions for treatment will be published shortly. Investigations on the fruit diseases have not yet reached the publication stage.

In Travancore the newly created department of agriculture have adopted measures to combat cocoanut disease in accordance with the recommendations made by the Imperial Mycologist. The infected area has been delimited and the affected trees have been segregated. As suggested by Dr. Butler, experiments with lime and different manures were conducted during the last two years to see whether these, when applied separately or in combination, improve the condition of diseased trees. The results so far obtained show that the application of lime and a mixture of oil-cakes, country ashes, fish manure and common salt, in the case of trees which are not old and on which the attack is not far advanced, produces perceptible improvement,

(*g*) *Entomology.*—Mr. H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, remained in charge of the section throughout the year. Mr. F. M. Howlett, B.A., F.E.S., Second Imperial Entomologist, was on leave during the greater part of the year. He attended, as Indian delegate, the International Congress of Entomology at Brussels in 1910 to which an exhibit illustrating the work of the section was sent by the Imperial Entomologist, who acted as Chairman of the Indian Sub-Committee of the Congress.

Mr. C. W. Mason, Supernumerary Entomologist, left the department on 19th December 1909, and his place was taken by Mr. T. Bainbrigge Fletcher, R.N., F.E.S., who joined the department as Supernumerary Entomologist on the 8th April 1910.

The Imperial Entomologist continued to direct the work of entomological assistants in the provinces, but their number is still only 16—five for teaching and eleven for field work—numbers in his opinion quite inadequate for the object in view, *viz.*, the bringing of the practical work in entomology to the notice of agriculturists. At present an increase in their numbers is not being made, as there are no European Entomologists to control their efforts.

Applied entomology now forms part of the course of training at five agricultural colleges in India. This will go a certain way towards the diffusion of correct entomological knowledge, but with such a small number of field assistants much progress in demonstrating how insect attack can be met and combated, is scarcely to be expected.

It is encouraging to note that the advice of the Imperial Entomologist has been availed of to advantage in certain provinces. In Madras substantial progress has been made; pests have been carefully studied on the lines laid down in 1906 in almost every district and good work done against the hairy caterpillar pest in South Arcot and against the Deccan grasshopper in the Northern Division. In Bombay very successful work has been done against the Rice grass-hopper, while work done against the potato moth and Deccan grass-hopper is expected to bear fruit this year. The methods devised by the Imperial Entomologist for controlling the potato moths were tried successfully in the Central Provinces, and this has led to

their adoption on a larger scale. An enquiry into the white-ant problem has been commenced partly at Pusa and partly at Hoshangabad in conjunction with Mr. Evans, Deputy Director of Agriculture, Northern Circle, Central Provinces.

Coloured plates of insect pests continued to be issued from Pusa. They are utilised in demonstration in all provinces and are also used in preparing show cases of crop pests for exhibitions, shows, and farms.

Collections of insects have been sent for the use of authors of coming volumes of the Fauna of India, and the general insect survey has been proceeded with.

In connection with research work in collaboration with the Imperial Agricultural Chemist the enquiry has been continued into the relation between weevil attack and the percentage of moisture in wheat, while the life histories and injurious habits of many insects were investigated.

Further attempts are being made to determine how far bees will thrive and be profitable in the plains. A new insecticide—Lead Chromate—introduced by the department has been thoroughly tested and is now on sale.

One of the principal features of the work of this section is the attention which is being paid to industries that depend upon the products of insects. Thus Eri, Mulberry and Tussar silk and the cultivation of Lac are taking up much of the time of Mr. Lefroy and his staff. The Eri silk industry has spread considerably in many parts of India; progress however is at present somewhat retarded by the want of middlemen for collecting the cocoons from the rearers and conveying them to the mills, but it is expected that private enterprise will eventually overcome this difficulty. At Pusa every process in the manufacture, from the rearing of the worms to the weaving of the cloth, is being conducted. The course of training in Eri silk manufacture was taken up by 19 persons, mainly people who wanted to take it up as an industry or employés of such. The large number of enquiries received at Pusa from all over India, indicate that there is a large future before the industry, to the development of which Mr. Lefroy and his staff are at

present energetically contributing. A very important part of the work of the past year was an enquiry into the races of the Lac insect in collaboration with the Forest Department which sent in samples from all parts of India and Burma. Assistance has been given to the Government of Japan in regard to Eri silk and Lac and the latter insect is being introduced into Formosa. Lac for seed was also supplied to the Bombay and Baroda Departments of Agriculture and to a Court of Wards' Estate in Orissa.

Mr. C. C. Ghosh, B.A., Second Assistant to the Imperial Entomologist, has published a translation in Bengali of "Indian Insect Pests" revised up to June 1909. The enquiry into the food of birds which was undertaken by Mr. C. W. Mason, late Supernumerary Entomologist, has been brought to a conclusion and the results will soon be published. Mr. Lefroy's work on "Indian Insect Life" is now available for all students and workers in Entomology.

(*h*) *Agricultural Bacteriology.*—Mr. C. J. Bergtheil, Imperial Agricultural Bacteriologist, was almost throughout the whole tenure of his office on deputation at Sirseah under the Behar Planters' Association. The section of Agricultural Bacteriology at Pusa was thus closed for work until the appointment of Mr. C. M. Hutchinson, B.A., who assumed charge of his duties as Imperial Agricultural Bacteriologist on the 27th December 1909. The principal work of this officer has been directed towards a preliminary examination of the bacteria in the soils of Pusa. The scheme of work has resolved itself into observation of occurrence and activity of bacteria at varying depths in the soil—

(*a*) with regard to varying species,

(*b*) with regard to their relations to soil chemistry.

In this connection Mr. Hutchinson points out that it is interesting to note that active nitrification in samples taken in February from plots attached to the pot-culture house has been observed down to a depth of 24 inches, the greatest amount taking place in the second six inches. An inhibitive action on nitrification of salts of magnesia when applied to Pusa soils has also been observed. Some work was also done on nitrogen fixation by bac-

teria. These enquiries into the distribution and characters of nitrogen fixing organisms in Indian soils have been undertaken as it seems probable that this source of nitrogen is of prime importance and that any information obtained as to the working of the processes concerned may lead to useful practical results.

At the request of the Imperial Entomologist, Mr. Hutchinson has undertaken a lengthy enquiry into the causes producing a very high mortality amongst Eri worms. This is still in progress.

Part II.

Outlines of the work conducted in the provinces.

1. *Bombay.*—Mr. G. F. Keatinge, I.C.S., remained in charge of the department throughout the year under report except when he went on one month's privilege leave. There were no changes in the superior staff. Messrs. G. D. Mehta, S. L. Ajrekar, and V. H. Gonehalli, holders of Government scholarships who were specialising in the different branches of agriculture in England, returned after completing their studies. Mr. Mehta has been temporarily posted to the Poona agricultural college for research and teaching work. Mr. Ajrekar has been appointed assistant professor of mycology while Mr. Gonehalli has been posted as Divisional Inspector of Agriculture in the Konkan. Mr. P. J. Bhatt is now the only Government scholar undergoing higher training in England. It is proposed to open an agricultural station shortly in the Kolaba district to be representative of the Konkan tract, for investigating the best methods of maintaining and improving the fertility of rice lands. Sanction has also been received for the opening of a farm at Larkana in Sind. The farms at Sukkar and Gokak which were taken in hand during the previous year are nearly ready for a beginning with experimental work. The only large tract which now remains without an agricultural station is the East Deccan where at present experiments are conducted on temporary plots only. The department held an agricultural conference and exhibition at Poona towards the close of September 1909. Among the subjects discussed at the con-

ference the following points came into special prominence :—(1) the difficulty of providing sufficient fodder for plough cattle, cows and young stock; (2) the demand for agricultural education for cultivators' sons; (3) the desire for a vernacular periodical dealing in a practical way with agricultural questions; (4) the desire that the agricultural department should largely increase demonstrations and establish a large number of depôts for seed, implements, and concentrated manures all over the presidency. The Government of Bombay as well as the agricultural department are taking measures to give effect to the recommendations of the conference as far as practicable. The importance of the first subject has been recognised and steps taken by the department to study it more systematically. An agricultural vernacular school has since been established at Poona for boys between the ages of 13 and 16 who are connected with the land and have passed the Marathi fourth standard. Instruction is given entirely free at present and the essential part of the course is the field work. An important and interesting proposal to form an agricultural high school at Mirpurkhas is under consideration at present. A monthly journal in Marathi called " Shetki and Shetkari " has since been started in Poona under the auspices of the Deccan Agricultural Association and the Government of Bombay have promised to take 1,000 copies for distribution. The demonstration work is increasing. The distribution of seed, implements, etc., is also steadily increasing, but the time seems to be approaching when this work will have to be taken over by private enterprise. The Divisional Inspectors of Agriculture are now able to approach the cultivators in their own homes and bring to their notice matters which interest them. They have established relations with leading cultivators in their charges and are freely consulted on many matters, while they are generally the moving spirits in shows and demonstrations. Twelve new agricultural associations came into existence during the year; giving a total of 31 now in existence. From these associations the local department has received much assistance in the distribution of seeds and implements and in the conduct of agricultural shows and demonstrations. The important work done by the department

in cotton, sugarcane, groundnut and other crops is reviewed below under their respective heads, while the progress of the Poona college is noticed in the section on agricultural education.

2. *Madras.*—Mr. M. E. Couchman, I.C.S., was in charge of the office of Director of Agriculture during the year. There were some changes in the staff of the Department. Mr. Cecil Wood, B.A., Deputy Director of Agriculture, Northern Division, was appointed Principal of the College during the year, Mr. Shepperson, the former Principal, having left the Department at the end of his three years' agreement. The post of the Deputy Director thus made vacant has been filled by Mr. G. R. Hilson, B.Sc. Mr. D. Anand Rao, B.Sc., was appointed Assistant Director on Rs. 250—15—400 on probation for a year. His headquarters have been fixed at Samalkota. A new post of Mycologist was sanctioned by the Secretary of State and Mr. W. McRae, Supernumerary Mycologist, Pusa, has been appointed to it. No new Agricultural Stations were opened during the year but the Director of Agriculture proposed the abolition of the Bellary farm as the existing site was, in his opinion, unsuited for purposes of experimental cultivation. The consideration of this question has, however, been deferred by Government to the end of the year 1911. The pumping experiments hitherto conducted at the Hagari agricultural station for the experimental irrigation of black cotton soil have been given up under the orders of the Local Government and the station is to be run hereafter as a dry farm. The Department has submitted proposals for the construction of a dairy at Coimbatore so that the students may be taught the principles of dairying. The work done by the Department in connection with sugarcane, cotton, groundnut, and improvement of cultivation methods, has been noticed in the sections of the report dealing particularly with these items. It is satisfactory to note that the staff have gained a thorough knowledge of the local cultivation round the farms and are on intimate and friendly relations with the *ryots*. The latter have lessened their suspicions regarding the work of the Department and now take a keen interest in the farms, visit them in increasing numbers, buy large quantities of seed from them, and in many cases adopt the

improvements recommended by the Department. The rapid spread of Mauritius and other foreign varieties of sugarcane is a good instance of this. Much more rapid progress may, therefore, be looked for in the near future. The Coimbatore College of Agriculture was opened by His Excellency the Governor on 14th July 1909. Its progress up to date is noticed in the section on education.

3. *Bengal.*—The Hon'ble Mr. W. R. Gourlay, I.C.S., now officiating Secretary to the Government of Bengal, held the post of Director up to the 10th of February 1910. Mr. W. H. Buchan, I.C.S., has since been in charge of the Department. The European expert staff remained unchanged during the year. Revised proposals for the re-organisation of the subordinate departmental staff have been submitted to the Government of India for sanction. A post of Assistant Professor of Mycology was added to the college staff. The work in connection with fisheries has now been incorporated with that of the Agricultural Department of the province. Important results have been got in connection with the manurial treatment and rotational practices for jute, paddy, and potatoes at the Burdwan Farm. Agricultural experiments and demonstrations conducted by Agricultural Associations and Government, Wards, and private Estates, have given much aid to the Department during the year, 106 members of agricultural associations and 28 others having voluntarily experimented. The " Quarterly Journal of Agriculture " continued to be published by the Department. It is gradually gaining favour with the public interested in agriculture. The Department also published during the year separate leaflets in English as well as in the different vernaculars of the province on matters of special interest and widely distributed them through the agency of District and Divisional Associations. Different varieties of spineless cactus were imported from America and tried in several places. In the Ranchi District they have thriven and are likely to be useful as a famine fodder in Chota Nagpore.

The Sabour College was opened in November. The staff now in residence consists of the Principal, the Agricultural

Chemist, the Economic Botanist, Assistant Professors of Agriculture, Botany, Mycology, and Entomology, and an Assistant Mycologist and Entomologist.

4. *United Provinces.*—Mr. W. H. Moreland, B.A., I.C.S., Director of Agriculture and Land Records of the Province, was in charge of the Department except for six months from November 1909 to May 1910, when the Hon'ble Mr. H. J. Hoare, I.C.S., officiated for him. The Agricultural Chemist, Mr. G. Clarke, F.I.C., proceeded home on a year's leave on the 6th November on account of ill-health, when Mr. H. E. Annett, Supernumerary Agricultural Chemist, was appointed to officiate for him. The post of Agricultural Engineer has been filled by Mr. S. A. Bunting. The Director reports that a gratifying feature of the year's work has been the increased interest shown by the public in the work of the Department and also that the latter has had much success in getting in touch with the people. No addition was made to the number of agricultural stations in the province. It was intended to organise two more at Attara and Benares during the past year but this has been impossible owing to financial pressure. The Government subsidy to the Rampur State Poultry Farm has been discontinued as a poultry-breeding and rearing farm has been started at Haldwani under the joint ownership of Government and Colonel Ward, an expert. A cattle conference was held at Lucknow in August 1909. It has furnished the officers of the Agricultural and Veterinary Departments with an authoritative body of information on the subjects discussed. A survey is being made, district by district, of the sources from which cultivators obtain their cattle. The object of this survey, which has been undertaken on the recommendation of the cattle conference, is to supply the necessary basis of facts for a policy of improvement in the supply of cattle in large numbers and of good quality. The Department undertook the organisation of the Agricultural Court of the United Provinces Exhibition which has been held at Allahabad and in that work has succeeded in arousing among manufacturers in England and elsewhere a practical interest in the potential market of Northern India for improved agricultural implements particularly designed to suit the special needs of

the market. In the matter of rendering assistance to the public, good work has been done by the issuing of chain pumps. The type of pumps supplied has been largely altered and improved by the Agricultural Engineer. The introduction of the centrifugal machine for separating molasses has met with much success, both as an adjunct to the Hadi process and also in the indigenous industry. The work on well-boring has shown a large increase during the year. Important work on the production of cottons possessing larger and finer staple than those at present cultivated is being undertaken by the Economic Botanist. For an account of this work I invite a reference to the January 1911 number of the *Agricultural Journal of India.*

Good work in the matter of cultivation of new crops and the introduction of new implements is being done by the agricultural associations of the province.

5. *Punjab.*—Mr. W. C. Renouf, I.C.S., held charge of the Department throughout the year. Mr. H. H. Corbin, Professor of Agriculture, left the Department on the expiry of the period of his agreement. Mr. W. Roberts, B.Sc., Supernumerary Agriculturist, Pusa, succeeded him on the 23rd August 1909. The Assistant Director, Bhai Sunder Singh, has joined his appointment at Lyallpur after two years' training at Pusa. A site for the second agricultural station was acquired at Gurdaspur and the laying out of the land for experimental purposes is being proceeded with. The head-quarters of the Deputy Director have been moved to Gurdaspur from 1st September 1910. Proposals have been submitted for regrading the upper subordinate staff. The Local Government have sanctioned the employment of an experienced date grower from Basra for three years with a view to the introduction of improved methods of date cultivation in the South-West Punjab, where conditions are favourable. The Agricultural and Veterinary Departments organised the Agricultural Section of the Exhibition held at Lahore in December 1909. The most important work conducted by the Department during the year was in connection with the distribution of agricultural machinery, in which much success was achieved by the Deputy Director. The sale of reaping machines, ploughs, and other implements of a type suited to

the requirements of the country is highly gratifying and indicates the willingness of the people to adopt European implements when capital is available and when the implements really fill a much felt want.

The work of the Department in improving the wheat crop and in drawing the attention of buyers to the possibilities of Punjab wheats for the European market is likely to meet with response. The question of the better storage and disposal of the crop is an extremely important one and the experiments which the Wheat Elevator Committee propose to make in the erection of elevators at Lyallpur and Karachi will be watched with much interest.

6. *Central Provinces.*—In the year under report there was no change in the controlling staff. Mr. P. Hemingway, I.C.S., continued to hold the post of Director of Agriculture. The Nagpur Farm is being remodelled as an educational college farm. In the near future two additional experimental farms will be required possibly in the Chanda and Jubbulpur districts—preferably in the area commanded by the larger irrigation works—to deal fully with questions relating to the Wainganga rice tract and the Jubbulpur tract. Implement depôts of the type already existing in Nagpur and Hoshangabad have been started on a small scale at Akola and Raipur. Chain pumps, bullock gears, and turn-wrest ploughs are selling well in the Southern Circle, while in the Northern, winnowers are in much demand. In the Chhattisgarh division the demonstration work of transplanting rice, irrigating wheat, etc., is fast increasing and was carried out on about 4,000 acres. It is proposed to take up similar work this year with the additional work of introducing jute in suitable places in the Nagpur division under the Ramtek reservoir and the sugarcane growing tract of Chanda. In the northern potato growing districts important work has been done in demonstrating the treatment of seed with crude oil emulsion as a preventive of insect attack. The agricultural associations are developing into useful working institutions and members of these did good work during the year in the distribution of selected seed. A noticeable indication of progress is the

growing number of private seed farms which are self-supporting. In the distribution of selected seed of cotton, wheat, and groundnuts the department has had much success. The department proposes to present agricultural *sanads* to private gentlemen in recognition of the assistance given by them to the department in its work of introducing and bringing home to cultivators various agricultural improvements. The agricultural gazette is attaining much popularity and the circulation is now over 1,000 copies better than last year. The progressive work done by the department in cotton and wheat and the distribution of seed will be found under the heads dealing with these subjects.

7. *Eastern Bengal and Assam.*—Mr. J. E. Scott, I.C.S., was in charge of the Department as Director of Agriculture from 1st to 30th July 1909, when he was relieved by Mr. F. W. Strong, I.C.S., who held officiating charge for the remainder of the year. The post of Assistant Director held by Rai B. C. Basu Bahadur, M.R.A.C., has been converted into that of Deputy Director. The appointment of a second Deputy Director of Agriculture was sanctioned during the year, and Mr. A. G. Birt, B.Sc., Supernumerary Agriculturist, Pusa, has been appointed to it. Mr. G. P. Hector, M.A., B.Sc., joined the department as Economic Botanist on the 23rd July 1909. The department has submitted proposals for the appointment of a fourth Agricultural Supervisor in order to make provision for a Personal Assistant to the Director. The head-quarters of Mr. Finlow, B.Sc., F.C.S., Fibre Expert to the Government of Eastern Bengal and Assam, were removed from Pusa to Dacca in May 1910. The work of laying out and standardising the soil of the Dacca farm was commenced during the year. Owing to the peculiar and undulating nature of the soil, which is a laterite, great difficulty is being found in obtaining uniformity. An attempt is being made to encourage and extend cotton cultivation in the hill districts of the province and in this connection a tour was made in these parts by the Imperial Cotton Specialist. Jute is being experimented with in the higher lands in the Chittagong district with hope of success. In the Khasi Hills the use of bone-meal and saltpetre as manures for rice was demonstrated in 15 villages.

Poultry-breeding on the basis of improvement of indigenous stock was started on the Dacca farm under the personal supervision of Mr. Meggitt, B.Sc., the Agricultural Chemist. The work of the department in sericulture will be found described in the sericulture section of this report.

Practical training is being given to sons of cultivators on Dacca and other farms in the laying out of experimental plots, the handling of implements and the management of cattle and stores. A departure has been made in the issue of the Year Book of the department, both in English and Bengali, for wide distribution in the province.

8. *Burma.*—Mr. S. A. Smith, B.A., I.C.S., acted as Director of Agriculture, till the return of Mr. J. MacKenna, M.A., I.C.S., from leave on the 28th September 1909. The latter officer was in charge of the department during the remainder of the year under report. The proposals submitted by the Local Government for the restriction of the superior staff owing to financial pressure have been sanctioned for the present by the Government of India. Accordingly Mr. E. Holmes-Smith, B.Sc., F.E.H.S., who was recruited to fill the post of Agricultural Economic Botanist, has been provisionally appointed Supernumerary Economic Botanist at Pusa. With the appointment of Mr. A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, to the post of Assistant Inspector General of Agriculture in India, the expert staff has been reduced to only two officers, a Deputy Director of Agriculture and an Agricultural Chemist. In view of the useful work which has been already accomplished and is still further capable of extension, it is hoped that it will soon be possible for the department to obtain the services of a second Deputy Director as well as an Economic Botanist. The main work of the department consisted in the conduct of the experiments laid down on the Mandalay farm, the continuance of the district agricultural surveys to form a basis for future work, special enquiries on such subjects as "taungya" cultivation and the jaggery industry, and the giving of help to local officials whenever it was wanted, either in the shape of advice or in the distribution of seed. The laboratory of the Agricultural Chemist is now in working order. The enquiry into the source,

supply, and agricultural value of the canal and river silts of Burma is approaching completion, and a considerable amount of work has been done on the soils of the Meiktila district. The botanical survey of the paddies of Upper Burma has been completed by Mr. Sawyer, Assistant Botanist. It is hoped to lay out the Hmawbi agricultural station for experimental work next season. The extension in cultivation of moisture resisting paddy introduced into the Akyab district by the department has been slight owing to the low prices paid by the Akyab buyers. The department conducted an enquiry into the toddy palm industry in its relation to the destruction of timber for fuel and consequent effect on the climate in the dry zone tract. An experiment of great interest was carried out at Maubin by a private gentleman in the extraction by machinery of fibre from plantain trees. The manufactory was inspected by the officers of the department and the industry promises to be a profitable one. The recent progress in the cultivation of groundnut is dealt with in the paragraph below under that head.

Part III.

Crops and Special Subjects.

1.—*Crops.*

(*a*) *Cotton.*—The improvement of this important crop occupies much of the attention of agricultural departments who have at their disposal the help of advice and suggestions from the Imperial Cotton Specialist. The principal lines of improvement being attempted are (*i*) selection and distribution of cotton seed, (*ii*) introduction of superior indigenous varieties and better methods of cultivation, (*iii*) hybridisation and (*iv*) trial of exotic varieties in localities where they are likely to succeed.

(*i*) *Selection and distribution of cotton seed.*—On the Surat (Bombay) farm specially selected seed of Broach cotton yielded between 500 and 600 lbs. per acre with ginning percentage of

32·5 which is an advantage of ·85 per cent. as compared with the result from an unselected sample. At Dharwar selection has been going on with Kumpta cotton. The object in view is the improvement in quality but this has been secured at the expense of the ginning percentage. It has been found that within a variety the quality varies more or less inversely with quantity. At Dhulia in Khandesh a prolonged study of the local forms has clearly established the fact that they consist of a mixture of at least six types and that some of these are better than others. The distribution of seed of the best type has already been commenced. Work on the same lines is being carried out at Koilpatti, Nundyal, Hagari and Bellary in Madras. At Koilpatti yearly selection of the best plants and also crossing them *inter se* have produced a variety which gives 34 per cent. of lint, an increase of 7 per cent. over the local crops and another variety with a staple which has been pronounced as equal to Upland Georgian and fit for spinning 40^s twist. Further trials on a larger scale are required to confirm this. The *jari* as cultivated in the Central Provinces is a mixture of the following four varieties mixed to a small extent with Upland Georgian :—(1) G. N. Rosea, (2) G. N. Cutchica, (3) G. N. Vera, (4) G. N. Vera Malvensis and also *Bani* plants. The relative value of the outturn of these different types after separation has been ascertained by Mr. Clouston, Deputy Director of Agriculture. Both in point of yield and quality Malvensis is a very promising variety and compares very favourably with *Bani*. The area under this variety is extending gradually as the seed is supplied from Akola and Nagpur Farms in larger quantities. Private seed farms are rapidly increasing in number in the Central Provinces and are self-supporting. The total quantity of selected cotton seed supplied to growers in the Central Provinces during the year was 123,500 lbs.; of this 43,000 lbs. came direct from the Government farms, principally Akola; the remainder was supplied by private farms.

The economic difficulty in connection with the development of a constant strain of improved seed is that an improved variety does not usually find a better market than one of ordinary quality. Such cotton may be valued by dealers at a superior

rate, but owing to there being no market for the superior class, cultivators do not get the price at which it has been valued. By auctions and otherwise the agricultural departments do in some cases attempt to obtain fair prices for crops grown at their recommendation, but such intervention on their part is limited in its possibilities. Unless the cultivator can get a better price for better quality, he will naturally prefer quantity, of which he is assured in the case of coarser and more prolific varieties. This difficulty, in addition to the further one of cultivators mixing good seed with bad, indicates the hard task which agricultural departments have before them in the improvement of this and other crops and shows that improvement on a large scale is impossible of accomplishment in a day.

(*ii*) *Introduction of superior indigenous varieties and better methods of cultivation.*—There has been a marked extension of this line of work, especially in Bombay and Madras. The cultivation of Broach cotton in Southern Maratha Country has now advanced so much that at the annual auction organised by the department in 1910 cotton was sold for a total value of Rs. 1,11,155 as against Rs. 8,398 in 1908. These figures are exclusive of Broach cotton sold privately by cultivators. On account of its considerably higher ginning percentage, its greater yield and superior colour, its cultivation is more profitable than the local Kumpta cotton. It is, however, necessary to import fresh seed every year from Surat district because it has been observed that Broach cotton acclimatised at Dharwar falls off in ginning percentage. At Dahod in the Punch Mahals, Khandesh cotton again fared very well in point of yield. This cotton has a special value for Dahod as it matures earlier and thus escapes the frost that sets in towards the end of December in that district. In point of quality, however, the cotton produced at Dahod is inferior to that grown in Khandesh. Mr. Henderson, Deputy Director of Agriculture in Sind, has found, from tests made with over three hundred varieties of indigenous cotton from all parts of India, that none of these equals the local Sindi cotton in cropping power. He has also established the important fact that this local variety responds readily to careful cultivation by Egyptian methods, that is, by

ridging and thinning. The practice of growing cotton broadcast is common to many parts of India, but in all provinces where such practice prevails experiments on the lines of those in Sind should be made to determine whether drill sowing and interculture appreciably affect the outturn in quantity or quality.

The efforts of the Department of Agriculture, Madras, have led to an extended cultivation of the *Karungani* variety in Tinnevelly. In the previous year 140,000 lbs. of pure seed was distributed by the department. All through the southern part of the Tinnevelly district Karungani cotton now predominates and it is estimated that 80,000 acres were sown with pure Karungani last year. The cultivation of this variety is profitable as it is not only superior in point of yield but also in the quality of lint to the ordinary variety *Uppam*. The introduction of the drill system of cultivation in Tinnevelly, where broadcasting was formerly universal, continues to make satisfactory progress. Including the seed farms, 2,100 acres of land were sown with the drill this year.

(*iii*) *Hybridisation.*—These experiments have been continued on several farms. At Surat (Bombay) plant to plant selection has been continued in the case of more promising crosses. The best cotton hybrids continue to give a lint valued considerably in excess of the local variety, and in some notable instances have obtained a higher relative value than ever before. The Bombay Department has been distributing seed of the best hybrid cottons among cultivators near the Surat farm. About 280 acres were sown the first year which has now increased to over 3,000 acres. The value obtained by the cultivators without the aid of an auction was 5 per cent. more than that for Surat cotton. The yield was also considerably higher than that of the ordinary crop. Another advantage noticed by cultivators was the uniformity with which the bolls opened. This reduces the charges for picking and watching and the cultivators' appreciation of this fact is shown by a keen demand for the seed. Arrangements have been made for the separate ginning of this seed cotton with a view to obtain the pure seed for distribution. Some crosses

made between different kinds of Upland at Gadag are yielding hopeful results. At Nadiad some crosses have been evolved between Texas and Bourbon and also between Egyptian, Sea Island and Bourbon. The purpose of crossing was to remove the objection to Bourbon that its bolls open badly, causing weakness in the fibre. The crosses made have proved superior in this respect. Perhaps the most important work in the hybridisation of cotton is being carried out in the United Provinces by Mr. H. M. Leake, the Economic Botanist. Several crosses have been recently made which give promise of being a great improvement on present local varieties. For a detailed description of this work as well as for a statement of results got up to date a reference is invited to the article by Messrs. Leake and Parr in the January 1911 number of the *Agricultural Journal of India.*

(*iv*) *Trials of Exotic Varieties.*—These have been continued on Government farms and in cultivators' fields. In Sind no Egyptian cotton could be sown in 1909 as there was no water available in the Jamrao Canal at the sowing season. For the same reason in the present year also it has not been sown anywhere except on the farm at Mirpurkhas. Steps are being taken by the Bombay Government to ensure a regular supply of water in the area commanded by the Jamrao Canal at the sowing season. With a view to encourage the cultivation of Egyptian cotton in that province the Government of Bombay have also sanctioned for one season the rebate of one rupee of land revenue on every acre of Egyptian cotton. When the regular supply of irrigation water is assured, the success of Egyptian cotton in Sind will depend upon (1) proper cultivation, including sowing before the first week in April, (2) avoiding " kalar " ground and if possible growing in rotation with *berseem*, (3) the provision of a system for disposal of seed cotton and ensuring proper treatment before sale, *viz.*, ginning, grading and selling at remunerative prices. Repeated trials have shown that Mitafifi alone is the variety to work upon in Sind and that unless arrangements be made to secure for the cultivator Rs. 12 or over per maund for Afifi, it will not pay to grow it.

From fairly extensive trials it is now certain that a good class of American cotton can be produced under average circumstances in Sind. It has a shorter growing period than Sindhi cotton and so it can be sown on inundation canals. There is consequently a very large area on which it can be grown. During the past year wherever it received fair treatment it was successful and yields of from 10 to 11 maunds per acre of seed cotton were obtained. The reports from Liverpool brokers were good both as to quality and ginning percentage. They stated that it was exactly the stuff required by Manchester and that they could take it in any quantity. During the present season it is being grown in Upper Sind where practically no cotton is grown and also in Lower Sind, with the exception of Larkana and Karachi districts. The establishment of buying agencies will, however, be a necessary adjunct to its successful cultivation.

After extended trials it has been definitely proved that cottons of Upland American type only thrive in a certain tract of the Southern Maratha Country at the southern termination of the Bombay Presidency. A form of Upland Georgian received from Cochin China and passing current under the name of Cambodia has given clear promise of a greater adaptibility to varied conditions. This variety is rapidly spreading in the Tinnevelly district of Madras. It is fit for spinning higher counts of yarn than any indigenous Madras cotton and with suitable treatment gives also very heavy yields. The local agricultural department is trying to push its cultivation by free supply of small quantities of seed as well as instructions for its cultivation. In the Bombay presidency it has been giving very good results at Dharwar for the last two years. The yield has been about 500 lbs. of seed cotton per acre with the high ginning percentage of 39. At Poona under a rainfall of about 25 inches it attained a good growth with produce satisfactory in quantity and quality. At Surat it has been found to be the only exotic annual which gives any promise of successfully competing with Navsari cotton in southern Gujarat. At Dhulia, while its yield was moderate, its cotton was valued nearly equal to Navsari.

In the Central Provinces the introduction of *Buri*—a type of Upland Georgian—has been progressing favourably. In years of heavy rainfall it gives a better yield than the local *Jari* and has also a better percentage of lint, and is wilt-resistant. Mr. Arno-Schmidt, Secretary, International Federation of Master Cotton Spinners' and Manufacturers' Associations, Manchester, was greatly impressed with its possibility. About 42,000 lbs. seed of this cotton was sold last year, and many cultivators have taken up its cultivation. Its tolerance for a higher rainfall gives promise of success even at Rajnandgaon and Raipur.

In the United Provinces where agricultural conditions are suitable for the cultivation of acclimatised American cotton, the want of a market for the produce has restricted extended cultivation and the local Government have meantime decided not to push it among cultivators.

In the Punjab a large area was sown with Dharwar American in 1909 but this advance does not appear to have been quite maintained in 1910 as Deshi cotton proved profitable in 1909. About 6,000 maunds were sold at auctions at Sargodha and Lyallpur and including private sales the total outturn was probably 7,000 maunds. This is a quantity sufficiently large for business firms to handle, but in spite of this, progress in establishing a market is slow. A slightly higher price than that realised as well as ordinary marketing facilities are needed to ensure cultivation on a really considerable scale. The department hopes to give the cultivator a somewhat better variety as regards outturn and staple than Dharwar American. For the present fresh seed is obtained from Dharwar every year.

In Burma experiments are being made at Mandalay with indigenous and exotic varieties and the agricultural department hopes in time to be able to recommend a cotton suitable to the country with a yield and staple superior to the indigenous varieties. During the year under report there have been numerous demands from private persons for American Sea Island cotton seed for trial in Kyaukse, Shwebo, Pakokku and Amherst districts.

(*v*) *Tree cottons.*—Experiments with tree cottons have resulted in failure. In the past strenuous efforts were made to introduce the Bourbon cotton in several parts of the Bombay and Madras presidencies but they were in the end disappointing. It now only exists as a mixture in fields in the red soil of Coimbatore and adjoining districts, and sporadic plants occur in many gardens throughout India and Burma. There is still some room to hope that with more careful selections of locality and more progressive methods of treatment and cultivation this variety may yet be found profitable to grow. In the Amherst district of Burma a private gentleman has put down 30 acres under tree cottons. The principal variety cultivated is the Pernambuco tree cotton. So far the plants are doing very well.

Trials with Brazilian, rough Peruvian, and a few others have failed completely. The chief objections to the introduction of a tree cotton as a field crop are those mentioned by Mr. Gammie, Imperial Cotton Specialist, (1) its urgent water requirements during the early part of its life, (2) the extreme likelihood of no crop being produced in the first year, (3) the risk of the very brittle branches being broken by the wind, (4) the increased danger from insect pests which are harboured and carried on from year to year, (5) the imperfect opening of the boll, a condition usually associated with a damaged state of the cotton, and (6) last but by no means least, a low outturn throughout (as compared with that of indigenous varieties) or a fairly high outturn in the first year followed by steadily decreasing yields in succeeding years.

(*b*) *Wheat.*—Considerable progress has been made by Mr. and Mrs. Howard in their investigations on wheat. These investigations have clearly proved the possibility of growing stronger wheats with better milling qualities than those at present exported from India. A further set of Pusa selected wheats was sent to Mr. A. E. Humphries, a past President of the Incorporated National Association of British and Irish Millers, for milling tests. Several of these wheats were found to possess great strength and high milling qualities and to be of the same class as American and Canadian Spring wheats which command the highest prices on the English market. The

results of this work are published in Pusa Bulletin No. 17. Many of the new Pusa selections and also some of the new hybrid wheats were grown on quarter acre plots. No rain fell during the period and no irrigation water was supplied; hence the crop derived its moisture from the water stored up in the soil from the previous monsoon. The yields varied from 25 maunds in the case of early varieties to 35 maunds per acre in the case of the later sorts and some of the new hybrids. About 2·5 tons of straw to the acre were produced. They will be grown again on an extended scale this year. The investigation into the influence of the environment on the quality of wheat which is being conducted by the Imperial Economic Botanist in collaboration with Mr. H. M. Leake, M.A., F.L.S., Economic Botanist, United Provinces, has been greatly extended during the past year. The results so far obtained, are being published as a Memoir. The most practical result obtained has been to show that the quality of any wheat depends largely on the proper and efficient preparation of the land, and that canal irrigation does not necessarily injuriously affect the milling qualities of wheat. The investigations on the natural crossing of wheat in India have proved that under canal irrigation in the Punjab crossing is exceedingly common. The results so far obtained in connection with these investigations are being published as a Memoir. Mr. and Mrs. Howard's book on "Wheat in India" was published during the year. It deals in a complete manner with the production, varieties, and methods of improvement of Indian wheat and will form a standard work of reference on the subject to students and agricultural departments.

At Lyallpur the classified wheats of the province have been multiplied for trials on a field scale in different districts of the Punjab. Seed should be available for extensive experiments this year. Twenty varieties of Australian wheats were also under observation but the conclusion arrived at was that their outturns did not, as a whole, compare favourably with those of indigenous varieties. About 60 plants were crossed with a view to increase, if possible, the nitrogen contents of the best yielding and milling varieties and to strengthen the straw, etc. The Punjab Department of Agriculture issued, during the

year under report, a bulletin based on Mr. and Mrs. Howard's conclusions regarding the suitability of Northern India for the production of stronger wheats and on enquiries from the Karachi Chamber of Commerce and the Association of British and Irish Millers. Attention has been drawn to the fact that the traders have been pursuing a wrong policy by shipping the weaker wheats. At present Punjab wheats leave Karachi in the form of standard mixtures which are made up at Karachi from the consignments received from up-country. The first step should be for the exporters to offer the higher rates for the " stronger " mixtures, and thus stimulate their cultivation. At the suggestion of Sir James Wilson, late Financial Commissioner, Punjab, the department of agriculture in that province is considering the despatch of fairly large consignments of the stronger wheats to certain millers in Scotland, who have expressed their willingness to purchase them, give them a working trial, and to furnish a report.

At the Powarkhera farm near Hoshangabad in the Central Provinces, irrigation experiments with wheat show that the yield is substantially increased if two light waterings are given in November and early December. But it has yet to be proved whether the heavy soils of that tract will stand annual irrigation without deterioration. On the same farm, it has been found that one deep ploughing at the end of the hot weather results in great benefit to the wheat crop.

Muzaffarnagar wheat, which is a soft white variety, appears to be suitable for Bengal in the matter of outturn. It is reported to have been successful wherever it was grown in that province except in Bhagalpur where it failed for want of rain.

In Burma the development of this important cereal is going on apace in remote parts, like the Chin Hills and the Kachin Hills of Bhamo. In the Chin Hills, the total yield was very favourable. In the Kachin Hills of Bhamo the agricultural department has introduced wheat cultivation with a fair promise of success. The department assists Kachins in the cultivation of wheat and also supplies seed and green manures. It seems probable that the crop might be

grown at every Military Police post in that district sufficient for its annual requirements. If this result can be achieved, the saving to the local Government will be very considerable as it will greatly reduce the cost of rationing the Military Police stationed there. Wheat cultivation shows little signs of expansion in Burma proper. Experiments at the Mandalay agricultural station with the Shan States' wheat, which is reported to be superior in milling quality to any of the Indian and Australian qualities, seem to indicate that it rapidly deteriorates under the changed climatic conditions. It is intended to distribute the seed of this variety in the frontier tracts, where it is believed that it would retain its qualities. For the sowing of wheat the department are at present advocating the use of the Indian seed-drill, as against the broadcast system. It has been demonstrated at the Mandalay farm that a considerable saving in the seed rate can be got by a use of that implement.

Experiments on the Manjri farm in Bombay show that the Australian crosses 22 and 27 and *Sufed* of Amritsar with their yields of over 1,600 lbs. per acre are worth pushing as irrigated wheats in the canal tracts of the Deccan. On the same farm the Gokak method of dibbling wheat on ridges was again tried with the result that a considerable increase in outturn was obtained; the extra cost of sowing is made up in the saving of seed.

At Dahod, where the brown soils are well suited to wheat cultivation, *Shet Parner* and *Bansi* have given very good yields and have also been valued much higher than local varieties. But hard wheats grown at Dahod tend to have spotted grains in seasons of heavy rainfall or where irrigation water is given. Work is now in progress to ascertain how far the occurrence of such grains can be controlled. There is also a tendency for the colour of the grain to change. In the Karnatic, where the growing period for wheat is very short, experiments have shown that any new variety to be successful must be an early maturing variety. On several farms of this presidency selection is being carefully carried on with a view to purify the varieties commonly grown mixed by cultivators. Special attention is

also being paid to the question of improving the outturn of Bombay wheats by selection of plants having longer ear-heads, better tillering habit and greater resistance to rust. Except in the northern parts of the presidency all the Bombay wheats belong to the Macaroni class and the improvement of quality is of comparatively less importance than that of yield.

In connection with wheat rust, an important series of preliminary observations on the effect of environment on the origin and course of the disease has been begun by Mr. Burns, Economic Botanist, Bombay.

(*c*) *Groundnut.*—It has now been clearly established that groundnut is one of the best crops for light soils in tracts where the rainfall is small, and the agricultural departments have seen the advantage of fostering its growth in all suitable localities. Its great disadvantage is the labour it requires and the cost of harvesting, and this, particularly in Burma, has tended during the last year to retard somewhat the increase in the area under it.

The Bombay department intends to demonstrate on the Dharwar farm a new method of harvesting which considerably reduces the expense. This consists in first cutting the stalks and then harrowing out the nuts with a heavy harrow. Some such method, if found practicable, would do much to popularise the crop in suitable localities.

Foreign groundnuts continue to gain in popularity in many tracts of the Bombay Presidency and are being widely distributed by the department. They were introduced into Southern Satara and the neighbouring States about nine years ago and have now gained such a foothold in some Talukas that scarcely a single field can be found with the local variety. Almost all the exotic varieties yield rather better than the indigenous. Some of these varieties ripen early and so escape the *Tikka* disease which affects the local variety. It has also been introduced in parts of Ahmednagar, Sholapur, and Nasik districts. The crop was not known in the Dharwar district prior to the opening of Dharwar experimental station. The successful cultivation of certain varieties of groundnuts without irrigation on that farm induced some enterprising cultivators to give

a trial to this profitable crop, and it is hoped that with systematic arrangements for the supply of seed of the best varieties, and by giving practical demonstrations in the cultivation of the crop, it will be largely taken up. Mozambique, Japanese large, Senegal and Pondicherry have given very satisfactory results as dry crops. It should be noted, however, that the heaviest yielders do not necessarily mean the greatest oil producers. But so long as the price continues to be independent of the oil percentage, the yield per acre of unhusked nuts must be the guiding factor in deciding which variety to grow for greatest profit. Experiments at Surat show that as a kharif crop Spanish peanut is much the most desirable variety to cultivate both as regards gross outturn and net profit. Among foreign varieties grown as irrigated crops, Virginia and Mozambique have done very well. The success of exotic varieties on the Dhulia farm was demonstrated to cultivators who are now eagerly taking up their cultivation.

Good progress continues to be made in the introduction of this crop on the west coast of the Madras presidency. But the crop does not grow well on that coast without manure. On analysis the soil has been found to be deficient in lime; the agricultural department is arranging to start manurial experiments with superphosphate during the current year.

The crop continued to grow in favour in Bengal, as is indicated by an increase in the demand for seed. It does well on soil which will grow no other crop. On saline soils in the Sunderbans a yield of 27 maunds per acre was obtained without manuring.

In Jalaun (United Provinces) agriculturists are beginning to display considerable interest in groundnut and numerous applications have been made to the department for small quantities of seed. One great advantage connected with its cultivation here is that the produce is readily marketable, a fact which will facilitate its introduction.

Groundnut is firmly established in the dry zone of Upper Burma, though the area under the crop contracted considerably during the year. The principal causes of this contraction were the low price ruling in 1908-09, and the suitability of the early

rains for sessamum. The short supply has already sent the local market rate up and it is expected that larger areas will in consequence be put under the crop.

The cultivation of groundnut was hitherto unknown in Kashmir but the experiments with a few varieties conducted on the Pratap Model Farm having proved most encouraging, seeds in small quantities have been distributed among land-holders interested in its cultivation and it is likely that the crop will ultimately establish itself in the valley of Kashmir.

Successful experiments were made on Surat farm to grow groundnuts as a subsidiary crop to jowar and cotton. The net profit obtained was much more than could be got out of either cotton or jowar grown as single crops. The people round Surat have shown their appreciation of the advantage of this method by quickly adopting it. The cereal rotation experiments undertaken at Palur to discover the best rotation crops to grow along with groundnut show that the rotation usually followed in South Arcot of *Cumbu* (Pennisetum typhoideum) and groundnuts is the best and the mixed crop gives a larger return than either crop grown alone.

In Burma the crop is rotated with sessamum, jowar and cotton, but a period of several years' fallow is usually allowed to a field after the cotton crop has been harvested.

Early maturing varieties escape the *Tikka* disease (Cercospora) but early maturity is apparently obtained at the expense of oil percentage.

Investigations carried out by Dr. Mann into the amount of oil in different varieties of the crop show that there is no constant relation between the percentage of oil in the seed and the variety but that this percentage seems to be determined much more by the circumstances under which a particular variety is grown than by the nature of the variety itself. Thus the same seed grown at Surat or Dharwar nearly always gave a richer nut than when grown in the Deccan districts, and the amount of cultivation seems to exert more influence than the nature of the variety on the percentage of oil. On this point, however, further information is necessary. This should be supplied by

the varietal tests which are being made in several of the provinces.

(*d*) *Sugarcane.*—The principal efforts of agricultural departments in connection with sugarcane are directed towards increasing the outturn per acre by the introduction of superior varieties of cane from other countries, improvements in the methods of cultivation, prevention of diseases, the use of suitable manures, and better processes of extracting juice and converting it into *gur* or sugar.

This crop is under special study at Samalkota in Madras, at Manjri in Bombay, and at Partabgarh in the United Provinces. The Mauritius canes introduced by the Madras Department of Agriculture in the Godavari have so far displaced the old canes, that the latter are seldom seen. In South Arcot where Mauritius canes were introduced only three years ago, there has been a rapid expansion of the area under cultivation, nearly 700 acres having been under that cane, out of the total area of 1,000 acres. A quarter of the area planted is irrigated dry land watered from wells. The superiority of this variety is demonstrated by the fact that its yield in juice is about twice that of the indigenous cane and it has the additional advantage of having a harder rind which protects it against the ravages of jackals. This cane has also been distributed to cultivators in South Canara and Malabar. In the former district trained coolies were sent in company with the farm manager to show better methods of cultivation. In Malabar the cultivation of cane is practically unknown, and all the details of cultivation as well as the manufacture of jaggery have had to be taught to the people from the beginning. The prospects are very promising as the canes grow to an extraordinary size on this coast. It is pleasing to note that the increased profits to the cultivators from the cultivation of the new canes more than equal the whole cost of the local department of agriculture.

There was a very large demand from cultivators for the new Barbados cane introduced by the Government Botanist and referred to in the last report. It has also been introduced into Malabar, South Arcot, Vizagapatam and Coimbatore. This cane, which is now cultivated in many parts of the world, has a

very high sugar content and is a most valuable acquisition to the country.

In Bengal the *khari* variety gave good results in Shahabad, Balasore and Birbhum. In Birbhum it is now grown on an extensive scale. The cultivation of sugarcane by the Behar Planters has not on the whole been successful and there is a considerable decrease in the area cultivated by them.

On the experimental farm at Jorhat in Eastern Bengal and Assam the two varieties *khari* and striped Mauritius have shown their superiority over other varieties for the last two years. After a final trial this year the department will take steps to introduce the best variety among cultivators.

In Burma some preliminary work has been done by the Agricultural Chemist on the testing of several of the more important canes of the province. There is probably a good deal of scope for the extension of sugarcane cultivation on the higher lands of the delta.

In Mysore experiments to determine the length of season through which sugarcane can be profitably planted are in progress. Plantings made from January to March have so far given good results.

In connection with the manuring of sugarcane the experiments at Samalkota show that the addition of superphosphate and potash, with or without lime, in addition to castor cake, does not pay. Ammonium sulphate continued to give good results with sugarcane on the Bombay farms. The department is now definitely recommending its use for sugarcane; and a good deal has been distributed to cultivators. The cost per unit of nitrogen as deduced by Dr. Mann from the current prices of the concentrated manures ordinarily used for sugarcane shows that ammonium sulphate is a cheap fertilizer for this crop. This year's experiments at Manjri indicate that the most economical top-dressing for sugarcane is a combination of safflower cake and ammonium sulphate and the efficacy of green manuring with san was also demonstrated.

Irrigation experiments on this crop undertaken to ascertain the most correct interval between two consecutive waterings and the quantity of water to be applied each time have proved

that an average application at each watering of about $2\frac{1}{2}''$ of rainfall after an interval of 8 days in hot weather and 10 days in the cold weather is the most advantageous for such soils as those of the Manjri farm. The experiments at Baramati have shown that if the interval between two consecutive irrigations of sugarcane does not exceed 10 days, the quantity of water now applied by cultivators can be safely reduced by one half.

The introduction of crushing and boiling appliances presents several features of interest and indicates considerable progress. Trials were made in the previous year at Manjri with a horizontal three roller cane crusher driven by an 18 horse power oil-engine. It gave an increase of 5 per cent. of juice over the three roller iron mill worked by bullock power. This means a gain of Rs. 40 per acre on a crop yielding 40 tons of cane. The cost of extracting the juice per acre also comes to about Rs. 8 less than with the bullock mill. Another power cane crusher having a six roller mill by Manlove Alliot & Co. installed at Baramati gave an extraction of from 5 to 7 per cent. higher than the three roller plant referred to above at a cost of only Rs. $3\frac{1}{2}$ per acre more for crushing. A number of the best cane growers have been impressed with the value of this crusher and are arranging to have them for their own use. As a result of demonstration on farms, shows, and district work by an itinerant fieldman in the south of the Satara district many cultivators have adopted the use of the Poona furnace for *gur* boiling. This appliance saves about Rs. 30 worth of fuel per acre of sugarcane cultivated as compared with the local furnace. Dr. Mann analysed Molassine or Molascuit which is imported from Australia as cattle food into the Bombay presidency and suggested that such a material could be made in our sugarcane districts where there is a considerable amount of waste of sugar-containing material. Accordingly a method capable of being used by any cultivator, however small, has been designed in the Bombay presidency for preparing a very valuable feeding material from the pith of the sugarcane and the scum from the *gur* boiling pans which is now almost entirely wasted. The material is relished by cattle and will form a valuable addition to the fodder available in and near the sugarcane tracts. The

method of preparation is described in leaflet No. 15 of 1910 of the Bombay department of agriculture.

The manufacture of sugar direct from the cane is beset with many difficulties in India. Among the principal are the small and scattered nature of the holdings, the impracticability of concentrating cultivation round a central factory, and the high value of *gur* as such in many parts of India. In these circumstances the use of small factories and small plants might prove advantageous, though the cost of production cannot be as low in their case as in the case of large factories with up-to-date equipment. The centrifugal machine which forms an adjunct to the process of sugar manufacture is finding a sale in the indigenous industry. In the United Provinces an English firm which has taken pains to adapt its machine to local conditions was able to sell several without Government assistance. The manufacture of the machines has also been started in a small way in the Punjab. The best results from this process appear to be got when a power centrifugal is employed. In the Sibsagar district of Eastern Bengal and Assam a power installation of this sort gave quite good results. The sugar manufactured brought from Rs. 11-3-0 to Rs. 13-8-0 per maund. During the year 1908-09, 480 maunds of sugar were manufactured and a total profit of Rs. 3,030 obtained by the manufacturer. There is reason to believe that small factories of this sort, if started in suitable localities, will meet with a considerable measure of success.

(*e*) *Tobacco.*—Experiments in the cultivation and curing of tobacco are principally carried on at Pusa, Burirhat (Eastern Bengal and Assam), and Nadiad (Bombay) farms. An exhaustive examination and classification of the types of *Nicotiana rustica* and *N. tabacum* have been made by Mr. and Mrs. Howard at Pusa and the results published in two Memoirs. This work has been undertaken with a view to study the amount of variation in the Indian types of tobacco, to obtain definitely described types for use in variety trials and for hybridization work, to facilitate the introduction and acclimatisation of tobaccos from other countries, to study inheritance of characters, and to produce new and improved types.

One of the main problems in connection with tobacco in India is to grow in the country varieties suitable for the making of cigarettes, which are now largely imported and which are ousting the *hookah* among Indian smokers. With this object the same officers conducted some preliminary curing experiments in conjunction with the Peninsular Tobacco Company with both American and Indian varieties. The Pusa varieties have given the best results so far. The Burirhat farm in Eastern Bengal and Assam conducts experiments with tobacco. Experiments are being made with a view to see if tobacco of sufficiently good quality for the manufacture of cigars and cigarettes can be produced in Rangpur district, which is one of the important centres of tobacco cultivation in India. So far experience has shown that several well-known foreign varieties of tobacco grow well at Rangpur, but owing either to defects in curing or to the unsuitability of the soil and climate, the leaf produced has been pronounced to be more or less deficient in the qualities which characterise tobacco used for superior classes of cigars and cigarettes. It is intended to continue the experiments in order to see whether these defects can be remedied. During the year under review, an experiment in the flue curing of cigarette tobacco, which consists in drying the tobacco rapidly by means of artificial heat, was tried with encouraging results. Some of the cigar leaf tobacco which was cured in the shade also appeared to have turned out well. Several valuations of tobacco grown on the farm were received and the opinion of the experts to whom they were submitted was on the whole favourable. The Nadiad agricultural station is situated in an important tobacco centre in Gujarat. The tobacco produced from *deshi* seed in that part of the Bombay presidency has generally very thick resinous leaves. Accordingly some years ago, seed of the famous wrapper producing tobacco was obtained from Sumatra and elsewhere for experimental cultivation. The varieties obtained and tested included Talaon, Havanah, Java P, Java D, Florida and Sumatra. They all seemed to suit the locality from an agricultural point of view, but they did not produce leaves of thin texture and mild flavour; on the contrary they gradually acquired the character of *deshi* tobacco referred

to above. It was supposed that this might be due to a very strong sun during the latter part of the growing season when the air becomes very dry; experiments were accordingly instituted to grow the Florida and Sumatra varieties under shade in the same way as is done in some parts of America. The shade grown leaf, however, was found to be extremely thin and papery to the feel while the yield was considerably lessened. Further trials have shown that the conditions prevailing at Nadiad are not favourable for producing leaf of very thin texture and mild flavour. There is reason to believe that varieties suitable for cigarette or pipe purposes would be more suitable to Nadiad conditions. Steps have accordingly been taken to obtain seed of the best American varieties for this purpose. Experiments in curing tobacco were continued in the barn erected for the purpose. Considerable difficulty was experienced in regulating the temperature and humidity and to obviate this a steam generator has been installed during the course of the year. Nadiad tobaccos are deficient in burning quality, which is due to the exceptionally low proportion of potash present in the leaf. A special experiment has accordingly been laid out with the object of seeing to what extent the potash content of the leaf can be increased by high manuring with potassic fertilizers. Deep ploughing for tobacco continues to give good results at Nadiad. Manurial experiments conducted on the same farm indicate that the most economical manure for tobacco for increasing its yield is a combination of farmyard manure and castor cake.

In the Madras presidency, Mr. T. H. Barry has acquired land from Government on lease for ten years to experiment with this crop. The best Indian cigars are usually covered with wrappers made from imported Sumatra tobacco, and Mr. Barry's object is to grow Sumatra varieties on the spot. His initial work, so far as the cultivation is concerned, gives promise of much success, but a good deal depends on the subsequent operations of drying and fermenting, which have yet to be experimented with. It is to be hoped that this venture will succeed. In consideration of the recently imposed duties on tobacco the prospects of the industry, if successful, have been materially heightened. In Burma there is every possibility of

Havana and Virginia tobaccos succeeding all along the Irrawady, if ordinary care is taken and weather conditions are favourable. Marked commercial successes have already been obtained in the Maubin district and both varieties are well established at Bhamo. The department proposes to distribute seed of these varieties to districts where they are likely to succeed and where the people have shown an interest in growing them.

(*f*) *Indigo.*—Scientific investigations on indigo are principally carried on at the Research Station of Sirseah (Behar) under a subsidy from the Government of Bengal. At Sirseah an up-to-date potculture house was built during the year and its equipment has been completed. Mr. C. J. Bergtheil controlled the work as Director of the Institute. Mr. F. R. Parnell joined the Institute as Economic Botanist in October 1909. This year marked the beginning of new lines of work at Sirseah though one or two points of previous work remained to be finished. Of the latter the production of indigo powder has been the subject of investigation. A powder machine was given a trial. After several modifications were made in the method of feeding and running the machine, it gave a maximum of 25 lbs. of dry powder per hour. Some further modifications would probably increase this outturn and it is hoped to try them on a future occasion. Apparently, however, what is wanted to compete with the synthetic product in the European markets is not a powder but a uniform paste. This is engaging the attention of the Sirseah Committee. The effect of nitro-bacterine was further examined by Mr. Bergtheil, the prepared culture being watered on to the crop when three inches high. The treated and control plots were each $\frac{1}{3}$rd acre and the yield of indigotin from each was practically identical. The experiments done in the preceding year to test the effect of copper sulphate as a plant stimulant have given negative results so far. It is proposed, however, to alter the conditions of this experiment and to continue it under a stricter system of control. Both Mr. Bergtheil and Mr. Parnell are engaged in the study of indican production and the part it plays in the metabolism of the plant. The discovery that indigo plants are normally cross-fertilized is an exceedingly important one, determining,

as it does, the methods which must be followed in successful selection work. It has shown that artificial self-fertilization must be made the basis of all such selection and the work has now been begun on that basis. A representative collection of indigo yielding plants from all parts of the world is being made at Sirseah in the hope that some may prove useful either for cultivation as they stand or as raw material from which more valuable varieties can be bred.

(*g*) *Jute.*—Mr. R. S. Finlow, Fibre Expert to the Government of Eastern Bengal and Assam, has concluded the study of types of the jute plant mentioned in the previous report. The number of distinct types has been found to be about 15. He is also investigating the chemical and microscopical characters of fibre samples obtained from each of the respective races of jute with a view to determining whether any race can be distinguished from others as producing fibre of superior quality. A number of such types have been singled out and seed sown from these in order to ascertain whether such characters are hereditary or only the result of environmental influence. Cross-fertilization experiments commenced in 1908 have been progressing favourably. They seem to show that an improved race, if introduced, would not be in serious danger of being speedily swamped by free hybridization with inferior races.

At the Cuttack agricultural station experiment in the manuring of jute showed that the best outturn was obtained with an application of 100 maunds of cowdung, 4 maunds of superphosphate, 3 maunds of kainite, 2 maunds each of sulphate of ammonia and sulphate of magnesium per acre. One hundred maunds of jute fibre produced on this farm were sent for valuation from the spinner's point of view and the report on the quality was favourable. Experiments with a view to its extended cultivation in parts where it is not grown were continued. In the Chittagong district the results so far show that excellent jute can be grown on high lands. More recently experiments have been undertaken with a view to utilise the low rice lands for jute in the period between the reaping of one paddy crop and the planting of another but the success of the

practice has been shown to depend greatly on the success or failure of the early rains.

Jute was grown successfully with irrigation last season at both Raipur and Telinkheri (Nagpur). This year's crops are also satisfactory. It is interesting to note, however, that *Corchorus olitorius* seems to thrive better, on the whole, in the Central Provinces than *C. capsularis*. At Belgaum in the Bombay presidency a crop of jute yielded fibre at the rate of 1,570 lbs. per acre valued at Rs. 6 per maund (82 lbs.), but the expenses of production are so high as to preclude the possibility of growing it at a profit in Bombay. At Lyallpur in the Punjab one sample of jute was valued by the Indian Jute Company, Calcutta, at Rs. 6-12-0 per maund, but owing to the high price of labour in the Punjab jute has poor chances of succeeding until machinery is devised to extract the fibre. There is also another difficulty to contend with and that is a very low temperature at the time of retting. In Burma small quantities of jute seed were distributed in Hanthawaddy and Bassein. Moderate successes have been achieved but the great danger is excessive rainfall at an early stage of the growth of the plant. Jute cultivation has been practically abandoned by the planters in Behar and is not likely to be revived there unless the prices rise again to the level of 1907.

Of recent years the watering of jute has come extensively into practice and is a blot upon the industry. The water is not applied by the cultivator who delivers dry jute but it is added whole-sale by the middle man who thereby reaps an illicit profit. The practice has spread to such an extent that in the preparation of the last Government forecasts an allowance has been made for water so added. This is not to be commended as it clearly condones the offence. It would seem that the trade has it very much in its power to stop the evil. At Naraingunj where European buyers control the market, wet jute is not dealt in. If the trade refused to buy wet jute the bad habit would undoubtedly cease.

(*h*) *Flax.*—This crop continues to be cultivated at Dooriah, Behar, on a considerable scale under the supervision of Mr. Vanderkerkhove, the Belgian Flax Expert, engaged by the Behar

Planters' Association but the experimental stage can hardly yet be said to have been passed. Questions of retting, manuring, etc., and an experiment with native seed occupied the attention of the Flax Expert. Last year's results, while indicating that the lower lands (Dhandhar) are likely to prove most suitable owing to the better supply of moisture, also tend to emphasise the necessity for intensive cultivation. Experiments with indigo refuse as a manure for flax demonstrated its high efficiency for that purpose. Such lands as had been treated with indigo refuse yielded an average weight of nearly 54 maunds of excellent straw per acre. On the other hand, from the similar land not directly manured rather less than 30 maunds per acre was obtained. The straw will yield fully 10 per cent. of fibre at £50 or more per ton, so that the gross outturn of the plot was increased by manuring to the extent of nearly Rs. 60 per acre. The whole question of manures for flax has been systematically taken up by the Fibre Expert to the Government of Eastern Bengal and Assam in collaboration with the Inspector General of Agriculture in India, and a comprehensive series of experiments has been started at Pusa this year with artificial and green manures.

The main object of the experiments with flax at Pusa during the season 1909-10 was to obtain information regarding the yield of straw to be expected from average good soil which had not been specially heavily manured for the crop. A yield of nearly 54 maunds of good straw was obtained from 1½ acres, representing 35 maunds, per acre. Although this yield is satisfactory, in an ordinarily moist year good results could not be expected from high land unless irrigation were resorted to.

Further information obtained on the subject of acclimatised seed indicates that new seed should be imported at least every two or three years if the quality of the fibre produced is to be kept up. As flax seed imported from Europe costs about Rs. 15 to Rs. 20 per maund, preliminary trials have been commenced in some of the cooler hill tracts of India, with a view to investigating the possibility of surmounting this difficulty. No definite information has yet been obtained; it is necessary first to ascertain the period of the year which is most suitable to the

growth of the crop. Definite trials with this end in view are being carried out in the Shillong district by the Deputy Director of Agriculture, and seed has also been sent to Kashmir and to Ootacamund.

As regards the importation of flax seed from Europe it has been found that no special precautions are necessary if the seed is despatched from Europe so as to reach India during the cold weather. The total cost of importation under these conditions is from Rs. 15 to Rs. 20 per maund. If, however, the seed arrives during the hot weather, or in the rainy season, it is necessary to dry it very thoroughly before despatching and also to pack it in hermetically sealed tin-lined boxes; otherwise the seed absorbs moisture and ferments to such an extent that it refuses to germinate on arrival. A large consignment of flax seed was actually imported in tin-lined boxes during the rainy season a year ago and the bulk of it was good; but its total cost approached Rs. 30 per maund. Such a price for seed means a very serious increase in the working expenses of a crop, the seed rate for which is over one and a half maund per acre.

As reported last year Mr. J. H. Lawrie of Baihatta, Kamrup, made a preliminary trial with flax during last season, but although the straw was of good quality the yield was not satisfactory on account of the unsuitability of the soil. It is hoped to continue the experiments this year under better conditions.

Last season an excellent crop of flax was grown under irrigation on a demonstration plot at the Agricultural College, Cawnpore. The weight of straw, the quality of which was very good indeed, corresponded to 40 maunds per acre. Further trials are contemplated for the coming season.

A small plot of flax was grown last year under irrigation at Hoshangabad and produced straw of fair quality. It is proposed this year to carry out trials on the linseed growing lands in the Jubbulpore District and also in the Nagpur District.

Several attempts have been made to extract fibre from the stems of ordinary linseed; but although linseed and flax are botanically identical, the two plants differ so greatly in their natural habits that very little success has hitherto been met with,

While the straw of good flax is smooth, unbranched, and flexible, the stem of ordinary linseed is generally rough, woody, brittle and often very branched. The fibre which can be extracted from such stems is not only very small in quantity, but it is also so inferior in quality as to be almost worthless. Last year, however, one crop of *deshi* linseed grown on heavily manured land under good moisture conditions showed a distinct improvement in the quality of the straw, which weighed nearly 40 maunds per acre, while the seed obtained approached three times the quantity produced by the imported flax.

So far as experience and experiment have shown up to the present the conditions necessary for successful flax growing in India appear to be the following :—(1) the land selected must have an abundance of moisture at the time of sowing and throughout the growth of the crop; if moisture is not present naturally irrigation may be substituted without detriment; (2) lands of the low-lying type known as Dhandhar in Bihar are best suited to its growth both on account of their texture and their capacity for holding moisture; (3) sowing can usually be successfully done between 20th October and 13th November.

It is hoped that the experiments now in progress on manuring and seed raising will throw further light on cultivation methods. If the plant can be grown under the above conditions, the industry promises to be a successful one.

(*i*) *Other Fibres.*—At the meeting of the Board of Agriculture held at Pusa in 1908 a Committee was formed to consider the present position and future prospects of the more important fibre crops of India. The findings of the Committee, amplified by information obtained by the Inspector General of Agriculture from Provincial Directors of Agriculture, have been published as Pusa Bulletin No. 15. In addition to the fibre crops cotton, flax and jute, dealt with already in this report, information was collected on several others which may be classified as (1) ryots' crops—Hibiscus cannabinus, Crotalaria juncea and Coconut, (2) Capitalists' crops—Rhea, Agave, Pine-apple and Sansiviera, and (3) fibre worth experimental attention, *e.g.*, Plantain, Malachra, and Sida.

In connection with (1) it may be noticed that Hibiscus cannabinus is grown for the manufacture of fibre chiefly in Madras. A mill for the spinning of the fibre and manufacturing it into gunnies has been in existence for some years at Bimlipatam, which may account for the considerable area of this crop in the locality. Another mill has recently been opened at Ellore in the Kistna district which may encourage and stimulate its cultivation. In most of the other provinces the crop is grown mixed with other *kharif* crops either as a source of fibre for home purposes or for its acid flower capsules which are much esteemed as a vegetable. The fibre is considered to be inferior to that of jute, but the plant possesses the advantage of being able to grow with a much smaller rainfall. Its cultivation is capable of much extension in the future.

San Hemp (Crotalaria juncea) is of great efficacy as a green manure and as such is grown in many parts of India. It can also be used as a fodder for cattle. Its fibre is held to be superior to that of jute but it is more difficult to clean. Like Hibiscus it can thrive under a much smaller rainfall than jute. One of its principal uses is to provide twine for the making of fishing nets. In the Tinnevelly district of Madras it is made into gunny bags. In parts of the Central Provinces, where the area under the crop has doubled in the last ten years, it has ousted wheat as a Rabi crop. A simple cheap machine to extract the fibre of this plant would probably help in extending its cultivation. Its great drawback is the cost and trouble of retting and extracting the fibre. There are several varieties of the plant, but the Fibre Expert to the Government of Eastern Bengal and Assam has demonstrated the superiority of Jubbulpore over Behar San. The former germinates more rapidly, acquires a greater height, and produces a better fibre.

The coconut palm is grown to the largest extent in southern Bombay and Madras, and in the Malabar coast districts the coir industry is important. In Bengal and Eastern Bengal and Assam the fibre is never extracted, the palm being grown for its fruit only. In Burma the cultivation of the palm has been taken up by a European in Akyab. At present the groves are only

being formed, but it is subsequently intended to start a fibre factory. A coir factory exists in Rangoon and the industry seems to be developing in Burma.

Agave and Rhea, since they give no return for several years after planting, are essentially capitalists' crops. Rhea has been extensively cultivated by indigo planters in Behar but has not proved a profitable crop. In the moister parts of Assam it is, to a small extent, cultivated by ryots. There it is possible to obtain five cuttings per annum.

In Madras the Glenrock Co. opened rhea plantations near Metapolliam many years ago, but the venture was not successful. Experiments conducted for several years past with it at Guneshkhind gardens, Kirkee, in Bombay have proved that the soil and climate are unsuitable for the plant. In Burma experimental plantations of B. nivea and B. tenacissima have been started by Forest Officers in Tharawaddy. The latter species is reported as growing well. Agave gives the most profitable returns in good land in a moist climate. In the United Provinces there are several plantations but these have not yet reached the cutting stage. In Madras the fibre has been extracted on a commercial scale in the Coimbatore district and there are some plantations in the Anantpur and Chingleput districts. In parts of the Central Provinces its fibre is used for making ropes and cloth. In Burma it is used in some prisons for rope making.

Sansiviera has been repeatedly tried by Assam planters but without success. Pine-apple fibre is not extracted on a commercial scale anywhere in India.

Malachra has only been experimented with in Bengal and Eastern Bengal and Assam. Its cultivation was not profitable.

Sida is being experimented with by the Fibre Expert. A particularly promising plant was obtained by the Imperial Mycologist in Lower Burma and its progeny are now being cultivated by Mr. Finlow.

An experiment is being made at Maubin, in Lower Burma, with plantain fibre, an extracting plant having been set up among the large groves of plantains grown there. The results of this venture will be of much interest.

The main findings of the Committee above mentioned with regard to these fibres were (1) that the cultivation of san hemp and Hibiscus cannabinus is capable of large and profitable extension in the near future; (2) a considerable increase of agave cultivation is possible in Assam and in parts with similar climatic conditions; (3) that successful rhea cultivation is limited to a comparatively narrow zone where both climate and soil are suitable; (4) that the rotation of food and fibre crops should be so arranged that the latter shall not tend to oust the former and that accordingly fibre plants that occupy the ground for one year only are preferable to those of perennial habit.

(*j*) *Tea.*—The Indian Tea Association continued to receive the annual subsidy of Rs. 15,000 from the Imperial Government and of Rs. 13,500 from the Governments of Bengal and Eastern Bengal and Assam. The number of tea gardens in Eastern Bengal and Assam at the close of the year 1909 was 934 against 930 at the close of the previous year. There was a net increase of more than 5,000 acres to the area under tea.

In the Darjeeling district the industry is in a fairly prosperous state owing to the good price got for tea possessing the unique flavour for which the district is noted. There are, however, complaints concerning scarcity of labour, blights, and deterioration of soil due to rain wash. In the Terai, owing to the mosquito blight, which has done much damage, and the scarcity of labour the prospects are not so bright. The increase in acreage above shown, however, seems to indicate that on the whole the condition of the industry is satisfactory.

In the United Provinces the condition of the industry is practically stationary. In the Punjab there has practically been no increase in the area under tea. In the latter province there was a fairly large community of European planters but now they have almost entirely disappeared. Most of the estates are now in the hands of Indians who generally prepare green tea. In the Madras presidency tea is cultivated in the Nilgiris, Wynaad and the Native State of Travancore. The area under tea is about 40,000 acres and the industry is in a flourishing condition. The industry has the benefit of advice from the scientific

officer engaged by the United Planters' Association of Southern India.

Scientific investigations were carried on at the Heeleaka Experiment Station in Assam by the scientific officers of the Indian Tea Association. This station has now been abandoned owing to the difficulty of obtaining a sufficient supply of labour. Negotiations are in progress for the acquisition of another suitable area for an experiment station. The chief feature of the investigations was the manurial experiments. These experiments at Heeleaka were undertaken to discover the best method of renovating deteriorated tea. They have shown that renovation can be successfully accomplished, and on the type of soil which is found at Heeleaka oil-cakes have proved to be the most successful manures for this purpose. These are indeed, at their present cost, the most economical form of manure for this soil and the best results have been obtained by applying them in small quantities frequently. Sterilised animal meal is an equally valuable manure. It has been shown that cattle manure collected and employed under the conditions usually obtaining on tea gardens does not possess the merit with which it is usually credited, the immediate result of its application being less than that of oil-cakes and its residual effect being negligible. Its use, unless it can be obtained cheaply, should be confined to special cases such as the manuring of infillings or to the treatment of soils which are deficient in organic matter. A series of experiments has been made with artificial manures, using them singly and in combination. Superphosphate and basic slag have been found to produce an increase in the yield of leaf on the Heeleaka soil, more especially when used in conjunction with nitrogenous manures. Basic slag acts but slowly, producing finally, however, an increase similar to that which is given by superphosphate. Potash manures appear to be of little or no use on soils of the Heeleaka type. Nitrates and ammonium salts produce rapid and large flushes when used alone, though a still larger outturn is obtained when phosphatic manures are present. Employed in small quantities at a time, their use has been followed by no appreciable deterioration in the state of the

soil or the appearance of the bushes, though a slight loss in the quality of the leaf is to be anticipated during heavy flushes which follow their application.

Of green manures *Mati Kalai* (Phaseolus mungo) has proved most effective though *dhaincha* (Sesbania aculeata) and *Arhar* (Cajanus indicus) used in conjunction with trench cultivation gave very good results. Increased cultivation alone has been found to improve materially the flushing power of old deteriorated tea such as that at Heeleaka and the value of trenching as a means of cultivation has been confirmed. The scientific officer of the Association has issued a pamphlet entitled " Experiments on the Quality of the Tea " in part I of which results are given of a series of investigations into the influence which such factors as climatic conditions, soil moisture and temperature, manures, etc., exert on the quality of tea leaf. The connection between these factors and the amount of total soluble matter and tannin in the leaf has been practically traced out and attention is drawn to the effect of heavy shade in lowering the tannin content of the leaf. In part II of the same pamphlet, the subject of tea manufacture is dealt with, and the results of an investigation into the effect of the firing process on the flavour of tea, which was carried out in the autumn of 1909, are described. At the request of the Darjeeling Planters' Association, the Officiating Imperial Mycologist conducted an investigation into the blister blight of tea, a disease which has been known for years in the North-East Assam, but which appeared for the first time in Darjeeling in 1908 and thereafter extended. The life-history of the fungus (Exobasidium Vexans Massee) before imperfectly known, was fully worked out, and after an extensive series of experiments, definite recommendations as regards remedial measures were made for the cold weather of 1909-10. General measures for the control of the blight have also been advocated. In the present season, the blight is continuing to spread and already threatens the Dooars and Terai. A report on the disease has been published as Pusa Bulletin No. 18. The Indian Tea Association has also issued two publications on the disease in tea nurseries, and the mosquito blight of tea, giving practical suggestions for their prevention and control.

(*k*) *Cassava.*—The continuance of experiments with this crop in most of the provinces has tended to show that its efficacy as a drought resister and famine food has been somewhat overrated. It was tried on all the Government farms in Bombay presidency proper. At none of the places did it give any promise of doing well. Although no difficulty is experienced in growing the sets, the outturn per acre has been found to be too small to make its cultivation profitable. At Dahod the crop yielded at the rate of about 4,000 lbs. of green tubers per acre, but the frost in December does considerable damage in that part. In the Punjab a very thorough trial was given to many varieties of cassava at four respresentative centres in Amballa, Dharuhera (Gurgaon district), Pathankot, and Lyallpur, under different conditions. In that province great damage is done to this crop by white ants, between the time the sets are planted and the time they become firmly established. Very special precautions were therefore taken at the time of planting the sets. The plants totally failed on very dry soil where they were not irrigated. Even with irrigation and under the most favourable conditions the outturn is not more than 10,000 lbs. per acre and this is on the assumption that there is no damage by white-ants. Actual outturns were very poor indeed owing to the attack of the latter. Cassava has been tried in Bengal but there it does not appear suitable for growth under field conditions as the plants are badly injured by strong wind.

In Burma it was tried on the Mandalay farm with fair results even though the soil was not quite suitable. The conclusion arrived at by the department is that if the plant be grown for food as a root crop it might form a valuable supplementary food stuff but the labour rate is still too high to make it remunerative as a source of starch. Its value as a famine food is discounted by the fact that it requires a great deal of water to start it, a fact which militates against its successful cultivation in the arid tracts of the dry zone.

Its cultivation is firmly established in Travancore, where it is reported that an average crop of fresh roots comes to about 20,000 lbs. per acre and fetches about Rs. 140. The department of agriculture of that State is making trials with various

varieties of this crop. The manurial experiments carried out show that a mixture of 320 lbs. of kainite, 240 lbs. of superphosphate and 160 lbs. of potassium nitrate per acre yields the best results. The conditions of Travancore appear to be more favourable for its cultivation than those of the drier tracts in which its introduction might prove useful. In the latter the position may be summed up by saying that as a general rule it requires irrigation for proper growth, the sets are liable to the ravages of white-ants, while the yield is too low for the plant to be an economic success. In consideration of these drawbacks it cannot at present be recommended to cultivators on a large scale.

(*l*) *Rice.*—This crop, which forms the staple food of the people in many parts of India, is under study in most of the provinces of India. At Lonavala in Bombay the principal experiments are made in connection with rice. It has been proved by Dr. Mann and Mr. Knight that the practice of *rab* burning (*i.e.*, burning loppings of wood, cowdung or other materials on a rice seed bed) followed by the cultivators in the Konkan has its chief value in the heating of the soil. They have also recommended certain economical and effective substitutes for *rab* for which reference should be made to the section on special enquries below. In the Madras presidency the work on paddy includes the trial of new varieties, spacing and manurial experiments and experiments with seed beds and transplantation. The Banku paddy introduced by the Department continues to give good results both at Palur and Samalkota. The spacing and green manuring experiments have given definite results. On the Samalkota Farm the standard planting is single seedlings 9″ apart and the seed rate is 6 lbs. The local seed rate is 70 lbs. and more per acre. The advantages of dibbling single seedlings which enables a large saving to be effected in the seed rate without any diminution in the resulting crop are therefore being demonstrated to cultivators. Reports received up to the time of writing show that the improvements recommended will be carried out on thousands of acres this season. For green manuring on paddy lands Sunn hemp and Sesbania Aculeata, which have given good results, are being recommended and

cultivators are taking up their cultivation. In Chhatisgarh Division of the Central Provinces efforts are being made by the local Department of Agriculture to bring into extended use the application of irrigation water and transplantation of seedlings in the case of this crop. The outlook in that part is very hopeful. In Bengal the *aus* variety of Central Provinces introduced by the Department continues to gain in popularity. In Behar it has been less successful owing to insect pests and other adverse conditions. But the seed tends to deteriorate and so it should be renewed every three years. The other varieties recommended by the Department are *Dadkani*, *Badshabhog*, *Samudraballi* and *Banktulsi*. In Eastern Bengal and Assam attempts are being made to introduce terraced cultivation of rice in the Naga Hills. The *Hatisali* variety promises to do well near Dhubri. It is strong in the stalk and stands erect and is immune from attacks of rats and mice. It is therefore becoming popular among surrounding cultivators. The use of bone meal in combination with saltpetre as manure for wet land rice is being demonstrated by the Department in the Khasi Hills with satisfactory results. In Burma a series of manurial experiments with paddy have been laid down on the Mandalay Experimental Farm, the chief feature of which is the attempt to introduce the practice of green manuring. The Department has also been trying to introduce moisture-resisting paddy into the Akyab District. Its extended cultivation, however, depends upon the price paid by the rice millers.

2. *Artificial Fertilizers.*—There are three principal classes of artificial manures, *viz.*, nitrogenous, phosphatic, and potassic. Potash is not a manure that is likely to be in great demand in this country owing to apparently already large available supplies in the soil.

There is bound to be a good demand for phosphatic manures in certain parts of India where the soil is known to be exceedingly deficient in phosphoric acid. In India we have practically unlimited supplies of bones and also large supplies of high grade mineral phosphates. But in order to be made effective, they require to be treated with sulphuric acid which at present is almost wholly imported. The cost of the sulphuric

acid makes this class of manures prohibitive for ordinary cultivators. If sulphuric acid could be manufactured here or procured cheap, there would be no difficulty in rendering available to agriculturists large supplies of phosphoric acid at a low and highly profitable figure. Experiments on various Government farms have shown that phosphatic manures can be used with advantage for several crops. On the Burdwan farm experiments for a term of years have proved that 3 maunds of bone-meal and 1 maund of saltpetre per acre is an economical manure for paddy. The Eastern Bengal and Assam Department of Agriculture has been demonstrating the value of this mixture with wet land rice in the Khasi Hills. A light dressing of bone-dust gave most remarkable results in the case of rice at the Raipur farm. The rice was transplanted, but unirrigated. The additional profit per acre resulting from the manure was Rs. 34.

Nitrogen is the most important element of plant food and as such can be safely applied to any class of soil. It can be obtained from nitrate of soda, sulphate of ammonia and nitrate of potash. Nitrate of soda is entirely imported. Sulphate of ammonia is at present almost entirely imported, comparatively a small quantity only being made here from the waste products of gas manufacture. Considering the greater concentration of sulphate of ammonia, this source of nitrogen is very much cheaper than nitrate of soda, because when carried into the interior there is an appreciable saving in freight charges. These manures are being tried on various Government farms. Their use was attended with a large increase in the outturns of cotton, *jowar* and *til* at Surat. Nitrogenous top-dressings have been proved to be very profitable for sugarcane, and the Department of Agriculture in Bombay is definitely recommending the use of sulphate of ammonia as a cheap fertilizer for this crop.

At present prices, however, artificials cannot compete with farm-yard manure or with oil-cakes for dry crop farming. A great deal of skill and experience is required to use them economically, and it is improbable that the Indian cultivators will have much use for them for some time to come. What is, there-

fore, required to be taught to the Indian cultivator is the greater care and method in the conservation of his farm-yard manure, the utilization of cattle urine which now practically runs to waste and the use of local oil-cakes. Oil-cakes are by far the most satisfactory manures for this country both from the point of effectiveness and of economy. Speaking generally the greatest defect in Indian soils is the want of organic matter. Accordingly oil-cakes do better than artificial manures and the effect of artificials is increased when organic manures are added to the soil. On the Manjri farm, the addition of safflower-cake to sulphate of ammonia very largely increased the outturn of sugarcane. Manurial experiments carried out on this crop at Dumraon show that sulphate of ammonia along with castor-cakes or saltpetre along with castor-cakes are very profitable. The demand for oil-cakes as manures is continually increasing in the Bombay Presidency. These and fish are the manures most in demand by cultivators in that presidency. The price of these has now gone up to such a point that sulphate of ammonia is only next to safflower cake in value per unit of nitrogen.

In Madras Presidency, investigations regarding the manurial substitutes for *pati mannu* (manurial earth) which is used by ryots to maintain the fertility of wet paddy lands in the Kistna Delta, have been continued. Good results were obtained from the mixed fertilizers applied in the previous year and a series of experiments in duplicate plots has now been laid down to determine whether any of the elements supplied in the mixtures could be omitted and thus the cost reduced. A similar experiment has been laid down at Coimbatore. This year's working shows that superphosphate has a greater effect than potash. If subsequent results confirm this, it will be possible to reduce the cost of the fertiliser by reducing the proportion of potash. At Uppalur the cumulative and residual experiments with a mixture of bone-meal and potassium sulphate showed that the effects of this manure last for at least two years. It is believed that with the present price of paddy it would pay cultivators to use a comparatively expensive fertilizer, when *pati mannu* is not available.

Experiments with poudrette at Dharwar upon cotton and *jowar* are giving good results. It forces the crop into good vigour and thus enables it to withstand the attacks of borer (*Chilo Simplex*) to a considerable extent. Besides an increase of produce there is a noticeable increase in *kadbi* (stalks used as fodder) in case of *jowar*. The remarkable residual effects of the application of night-soil are strikingly shown in the experiments at Surat. It was applied in 1904 and has greatly benefited the *jowar* and cotton crops at Surat during the last six years. In the case of *jowar*, the average net profit was about Rs. 50, while in the case of cotton it was Rs. 33 per acre throughout the period. The striking feature about the *jowar* plot manured with poudrette is the great vegetative growth produced; thus, in addition to grain, there was an increase of about 2,000 lbs. of *kadbi* per acre over that yielded by the farm-yard manured plots. These results bear striking testimony to the truth of Sir F. Nicholson's dictum as to the enormous losses which India suffers through neglect to make use of this material.

The success, however, in the endeavours of the Department to cause an increase in the use of fertilizers in this country depends primarily upon the cost at which the plant foods, nitrogen, phosphoric acid and potash, can be purchased, and secondarily their most effective and economical use. As regards cost there is much evidence to show that experiments have often been considered unprofitable because the prices paid for the manures were found to be exorbitant and prohibitive Their residual value to subsequent crops has often been ignored and the necessity which exists for the application of carbonaceous material along with the plant food has not always been realised. What is required is that the manures should be purchased in the best and cheapest market and should be applied in the most effective and economical manner. At present the cheapest form of plant food in India is that contained in farm-yard manure and oil-cake and if these were procurable in unlimited quantities it would scarcely be necessary to consider the question of artificials. But the supply of these two materials in any particular locality would soon be exhausted, were their use on a large scale sustained. We should then soon be obliged to turn to

artificial fertilizers as aids or substitutes. As has been pointed out above those manufactured in the country would not necessarily be the cheapest, for the cost of production has to be taken into consideration. Thus owing to the high price of sulphuric acid in India the conversion of local phosphate into superphosphates would make the price of the plant food, phosphoric acid, prohibitive. It is found therefore that the best and cheapest way to procure it is to import mineral superphosphate from England and in order that the cost of freight may fall as lightly as possible on the phosphoric acid, it should be purchased in the most concentrated form. In this way phosphoric acid can be landed in India at as low a figure as 2 annas per lb. Similarly nitrogen can be landed in India in the shape of sulphate of ammonia at about 6 annas a lb. and potash as sulphate or muriate of potash at 2 annas a lb.

It is possible that Indian saltpetre may be the cheapest source for nitrogen and potash if the price is fairly divided between the nitrogen and the potash, but it is possible also that the large proportion of potash to nitrogen in this form of manure may make its continuous use undesirable. This difficulty would, however, be overcome by a judicious admixture of the Indian saltpetre with other nitrogenous manures and if this is done, I have little doubt but that nitrate of potash is the cheapest form of supply for nitrogen and potash in this country.

The subject of the most economical use of manures available in India was considered by the Board of Agriculture this year. It was resolved that every province should prepare a full note on the manures available and on the experience acquired in their use and that these reports should be forwarded to an officer to be appointed by the Inspector General of Agriculture for collation and arrangement in time for submission to the next Board.

3. *Distribution of Seeds.*—During the year under review the demand for pure and farm grown seed continued to increase so much that some of the provinces had to organise the work in a more systematic way than in previous years.

In Bombay the total quantity of seed of different varieties of cotton distributed during 1909-10 amounted to 39,224 lbs. Seeds of various groundnuts amounting to 11,760 lbs., and sugarcane sets from Manjri farm were distributed on a large scale. A large quantity of potato seeds of Italian variety was distributed among cultivators of Belgaum district.

In the United Provinces, the Department of Agriculture distributed 1,200 maunds of seeds of various kinds. The largest demand was for pure wheat seed which was partly met from Cawnpore and partly from Sisauli seed farm. The District Board at Faizabad opened a new seed depôt at Akabarpur during the year. The Department of Agriculture intends to open a seed depôt at Benares, as soon as the agricultural station at that place is fully equipped. The Court of Wards maintains a seed depôt at Jaunpur. The total quantity of seed distributed during the year by the above seed depôts apart from the seed distributed by the Department was 12,000 maunds.

In Bengal the whole work was formerly done at the central seed store, Calcutta. But it was found to be more than the Superintendent of the store could manage effectively. Each farm was therefore made a distributing centre for applicants of its own locality, while the central seed store now stocks seeds which are not grown on Government farms together with some quantity of farm grown seeds to meet the demand from the surrounding neighbourhood. During the year 2,442 maunds of seeds of different crops and 81,650 cuttings of sugarcane were supplied in this way.

In the Central Provinces demonstration plots serve the purpose of seed farms. There are also private seed farms which under the supervision of the officers of the Department of Agriculture sell selected seed to cultivators. Seed farms for cotton and *jowar* have during the year under report increased in number. The seed depôt at Powerkhera Government farm distributed over 21,000 lbs. of selected wheat seed during 1909-10. Besides these the Department of Agriculture distributed 2,000 lbs. rice, 11,000 lbs. groundnut seed and a large number of sugarcane sets.

During the year under review the Madras Department of Agriculture imported some plants of a good variety of orange from Northern Burma and distributed them in the Nilgiris, Kodai Kanal and Coorg. The seed of newly imported Transvaal varieties of maize was distributed to selected ryots in Tanjore and Arcot, and large quantities of sugarcane sets in South Canara and Malabar. In the southern division cultivators continue to show an increasing interest in the farms by buying large quantities of seed from them, and in some cases the demand considerably exceeded the supply. The Palur agricultural station supplied the cultivators with 31,000 lbs. of groundnut seed, 8,000 lbs. of paddy and 500 lbs. of other miscellaneous seeds. At the Samalkota station 14,150 cane sets were distributed.

The seed store opened at the Dacca farm in Eastern Bengal and Assam in November 1908, did a considerable amount of work by way of distributing seeds during the year. The total quantities of seed and plants distributed from the depôt aggregated 534 maunds which were mostly grown on Government farms and tested carefully before issue or purchased direct from ryots by the officers of the Department. Sugarcane sets, plantain shoots and pine-apple suckers were also distributed. During the last potato season 117 maunds of Naini Tal and 116 maunds of Darjeeling seed potatoes were supplied to cultivators in the province. Temporary depôts were opened for the purpose of distributing potato seed at Jorhat, Rajshahi, Dacca and Rangpur.

The Burma Department of Agriculture distributed coffee seeds to a limited number of persons in a few districts and continued, in accordance with former practice, the distribution of Havana and Virginia tobacco seed to certain districts. Small quantities of jute seed were supplied to applicants with full instructions. Fourteen hundred plants of Malta lemons obtained from the Agri-Horticultural Society of Burma were distributed in seven places.

Considerable work has been performed in collecting and distributing seeds of various varieties of wheat, oil-seeds, oil-cakes, *tur* (*Cajanus indicus*), fruit trees, leguminous fodder

plants and various agricultural products of India, for the Departments of Agriculture in Australia, Germany, Italy and South Africa and for the United States Department of Agriculture.

4. *Distribution of Implements.*—The introduction of new and improved implements and the transference of superior indigenous implements from one province to another continue to make good progress. It is satisfactory to note that European implement makers are beginning to realise that progress must take place rather along the lines of improvement of the indigenous types than by the mere introduction of those which have been found suitable in Europe. The demands of India are for light and simply constructed implements, capable of being repaired locally and suitable for bullock traction. For these reasons, in addition to their cost, heavy European implements have in most cases been found unsuitable for India. The agricultural associations which have been formed in the various provinces have given much help in the introduction of useful implements and machines while the agricultural shows and exhibitions which are being held all over India have also been instrumental in popularising their use. In certain provinces, owing to the increasing cost of labour, the need of labour-saving appliances becomes greater every year. In the Punjab, as many as 72 reapers were sold this year, each costing Rs. 255. The new machines have mostly gone to the same villages as those of the last year or to the surrounding ones. Another interesting feature is that co-operative purchasing has increased considerably, the number of partners ranging from three to as many as ten. The Agricultural Department holds at Lyallpur monthly classes of instruction in the use of agricultural implements. A new type of winnower designed for dealing directly with the *bhusa* and grain mixture on the threshing floor has been tried this year with excellent results. A number of them will be put on the market for the next season. The problem of implements for wheat threshing has been left in the hands of private engineering firms and has not been tackled by the Department. Last year a steam thresher was given an extended trial at Lyallpur but local conditions are all against expensive

machinery, owing to the absence of the practice of stacking and the shortness of the threshing season. Experiments made at Lyallpur, however, have led to the hope that it may be possible to produce a moderately cheap bullock power threshing machine which might become popular.

In connection with tillage implements a light furrow turning plough used at the Lyallpur station has been found a success. Without advertising, over 200 of these ploughs, costing from Rs. 26-8-0 to Rs. 30 have been sold, and private firms are now taking up their manufacture. A specially designed spring tooth harrow has had a fairly large sale.

In the United Provinces the principal demand is for low chain-pumps and ploughs. The type of chain-pump hitherto supplied has now been largely altered by the agricultural engineer with the result that they are now distinctly more effective and durable. The number of iron ploughs issued during the year was 525 (against 363 in the previous year), the Meston type being most popular. In these provinces, the centrifugal for separating molasses has been in demand both in the Hadi process of sugar manufacture and in the indigenous industry. The system formerly adopted of having sub-centres for the demonstration of implements has been continued as giving the best results. Implement depôts are maintained at Cawnpore and Partabgarh.

In the Central Provinces, implement depôts have been started at Akola and Raipur in addition to those already opened at Nagpur and Hoshangabad. Chain-pumps, bullock-gears and turn-wrest ploughs are selling well in the Southern Circle, while in the Northern Circle there is a brisk demand for winnowers. A *mistry* in Hoshangabad turns out a number of these simple machines comparing favourably with those imported from America. Cases have been reported during the year of malguzars purchasing several machines and hiring them out at reasonable rates to their tenants.

In Bombay there are three agencies for the demonstration and distribution of implements—(1) Agricultural Department, (2) private firms, (3) the more advanced Agricultural Associations. The Department co-operates with the two latter. The

chief descriptions of implements distributed are ploughs, chain-pumps, chaff-cutters and iron cane mills. More orders are received by the Department than it can execute. A native firm in Belgaum has entered the trade and sells about 200 ploughs a year. In Sind, there is a workshop at Mirpurkhas making ploughs, threshing machines (Egyptian pattern), water-lifting apparatus and levelling scrapers. The workshop made about 500 ploughs in 18 months. In the Department's Bulletin, No. 38 of 1910, an account is given of a scientific device of a very simple nature for the detection of underground water. This instrument, the principle of which is electro-magnetic, is made by Messrs. Mansfield and Company. It has given good results in Bombay and promises to supersede the old empirical methods formerly used in choosing site for wells and water supplies.

In Bengal, both the iron mill for crushing sugarcane and the pan for boiling juice have been greatly appreciated by the sugarcane growers of the Orissa Division. The use of the Meston plough has also extended considerably. A miscellaneous number of threshers, maize hullers, reapers, pumps, ploughs and other implements were tested during the year.

In Burma, an improved type of angle harrow has been made at the Mandalay farm and has been found very suitable for getting a good tilth on the black cotton soil. The use of the Indian seed drill and the Hindustan plough are also being recommended to cultivators. In this province there is at present much need for a simple appliance for harvesting groundnut and for a simple furnace for boiling jaggery in the toddy palm tracts. The present system of boiling is very destructive of timber which can ill be spared in the dry zone.

The best means of supplying improved agricultural implements to cultivators was referred to the Board of Agriculture this year. The Board recommended that the Department should work towards a system under which such profit would be charged on the sale of implements as would leave a margin to any private firm that might elect to enter the business and relieve the Department of the work. It was of opinion that the supply of implements should not be regarded as permanently

forming a part of the Department's functions, though for the present the Agricultural Departments in most of the provinces must be prepared to stock implements, and for some considerable time to interest themselves in the introduction of improved implements, firstly by demonstration and instruction work and secondly by affording facilities for co-operative societies and agricultural associations to undertake the study of local retail. It was further agreed that in connection with orders for implements received by Departments from cultivators only such implements should be purchased from firms as had been previously approved by the Department.

5. *Irrigation.*—Good progress has been made by the various Departments of Agriculture in their efforts to promote well-sinking and in demonstrating to cultivators the use of oil-engines and pumps in the utilisation of sources of water hitherto unused.

The Bombay Department of Agriculture has been carrying out well-boring operations in Gujarat since 1908, with the help of an overseer trained in the use of Cawnpore tools. There are large areas in Upper and Lower Gujarat where conditions are suitable for working with these tools. In 1908-09, 25 wells were bored of which 15 were successful. The average cost of boring was Rs. 1-7-1 per foot, and the cost of piping in the successful well about Rs. 1-4-0 a foot. In 1909-10, 55 wells were bored of which 31 borings were successful. Altogether 30 wells were bored in the Kaira district of which half proved successful, the most promising locality being Borsad taluka and the adjoining Umetha State. In the Ahmedabad district out of 8 borings made 7 proved unsuccessful. It has been found that in Virumgaon and Dholka talukas the water is too deep for the Cawnpore tools to reach at a remunerative rate. The tract to the south-east of Nadiad also was found to be unfavourable. In the Surat and Broach districts all the borings were successful. As a result of this work not only was additional water obtained in the case of successful borings but in several cases the quality of the water was improved as well. In some instances the water supply was increased to such an extent that the well owner is

now able to use an oil-engine to lift the water. There are many favourable sites for the location of pumping plants on the banks of the Bhima, Krishna, Ghat Prabha, Mula and other rivers in the Deccan, the water of which at present runs to waste. The Agricultural Department has therefore purchased several oil-engines and pumps with a view to ascertain how far such pumping plants are suitable for lifting water economically from these rivers. Mr. A. A. Musto of the Public Works Department, whose services have been lent to the Department for employment as agricultural engineer, is in charge of these operations. Definite results as regards their working have not been arrived at.

In Madras the work done in connection with well-boring and installation of oil-engines and pumps by the Department of Industries is well known. Satisfactory progress continues to be made in that presidency with oil-engines and pumps for purposes of irrigation. Trial borings in the southern parts of the presidency have indicated the existence of large water-bearing strata similar to those in Chingleput district. The well-boring operations are therefore being extended to all other parts of the presidency where favourable conditions prevail. Most of the boring operations have taken place in the alluvial tracts of the Chingleput district. In Coimbatore district where the under-ground springs are met with in fissures in hard rocky strata, wells are being improved by blasting the rocks with dynamite. It is under contemplation to purchase a key stone driller or Calyx drill worked by steam power to put down bore holes in hard clayey tracts of the upland districts and in the rocky strata like those of the ceded districts and Coimbatore. A machine of the former type has been purchased by the Department of Industries on behalf of the zamindar of Davarkota, Kistna district. The results gained from working it will, it is hoped, be useful in indicating the lines on which boring work should proceed in that presidency.

In Bengal very little progress has been made in well boring operations for want of expert supervision and control over the borers of the different districts. The demand for borers was small and the staff has been reduced. During the year under

report only 38 borings were made—12 in Gaya, 10 in Bhagalpur, 8 in Patna, 6 in Shahabad and 2 in Motihari. With a view to secure more efficient supervision, the head-quarters of the staff were removed at the close of the year from Sabour to Gaya to which latter district the work will be for the present confined. It is considered that the services of an expert engineer will be necessary in order to efficiently supervise the work.

In the United Provinces well-boring work has considerably increased. During the year under report there was an increased demand for sinking pipes to deeper springs in existing wells. Of the 292 trial borings made 72 per cent. were successful. The demand for this work is largest in the Meerut division and also in Kheri and Bahraich where an increase in the number of wells is much needed. The supply of water was improved in over 800 existing wells. The daily average speed of boring is being gradually improved with a view to reduce the cost of boring which is paid by the owners of wells, and in the light of experience gained various changes are being made in the design of boring implements. Arrangements are also being made for the speedier execution of repairs. The agricultural engineer has prepared a report on the year's work in connection with percolation wells. His services have been found very useful in improving agricultural machinery and boring implements in particular.

In the Punjab the scheme for making trial borings, tubing wells, and generally improving the water supply has been commenced. The necessary supervising staff has been trained at Cawnpore and eleven sets of boring apparatus have been purchased. The districts of Rohtak, Karnal, Hoshiarpur and Gurdaspur have been selected for the first operations.

In the Central Provinces a boring apparatus of the sludger type was obtained from the United Provinces but found to be unsuitable, as the areas where well sinking is most necessary are situated mostly on trap rock. With the best type of rock boring machinery these operations could be undertaken, but the cost would be prohibitive owing to the necessity of employing the very best type.

Experiments are in progress in several provinces to test the quantity of water required by each irrigated crop. The experiments at Baramati and Manjri in Bombay show that the quantity of water (400,000 cubic feet per year, equal to a rainfall of 110 inches) at present applied by the cultivators to the sugarcane crop can be safely reduced to one half without any injury to the crop, if watering is given every ten days. Irrigation experiments conducted with cotton on the Surat farm again show that greatly increased profits can be obtained from waterings given to crops like cotton and jowar in that tract. The cost of raising the water from a well is, however, so high that it does not pay the cultivator to irrigate with well water. The extension of tank irrigation or the introduction of a canal system from the Tapti would seem to be useful in this direction. As, however, the black soil is extremely deep and retentive of water, with impervious substrata, it is necessary to repeat these experiments for a series of years in order to determine whether irrigation on soils of this type may not ultimately produce deleterious effects. The experiments at Koilpatti in Madras again show that the system of ridge and furrow irrigation is advantageous in the rainy season and it is encouraging to record that several of the onion growing villages in the neighbourhood of the farm are adopting the practice. There is no doubt that this system effects a considerable saving of water.

The subject of agricultural engineering with special reference to well-boring and well-irrigation was referred to the Board of Agriculture in 1910. The demand for a permanent engineering official in the Agricultural Departments arises from the fact that it is difficult to get skilled mechanics in the mofussil, while the experts of private engineering firms have not the time and knowledge necessary for the study of local conditions. In addition, the agricultural officers cannot be regarded as having the amount of technical knowledge necessary for the work. An agricultural engineer, in addition to the work of properly setting up pumping plants, would also be useful in guiding the well-boring operations, in designing, constructing and improving ordinary agricultural machinery and implements suitable for the country, and would be qualified to give advice to cultivators

and others on the subject. The Board resolved that the work of well-boring is such as calls for the technical control of a trained mechanical engineer. Other resolutions of the Board on this subject will be found in the published proceedings of that body.

6. *Dry Farming.*—The term " dry farming " had its origin in America, where the system is now in vogue in the more arid areas of the States. The practice refers to cultivation under a small rainfall, using such methods as shall conserve the maximum amount of that rainfall for the growing plant. The system is no new thing. In certain parts of India a good crop is obtained by cultivators with 15 inches of rain if it is properly distributed and there are many cereal and other crops which are suitable for dry land cultivation. But a systematic knowledge of each of the operations which go to make dry farming possible is highly necessary to enable the Agricultural Departments to see whether local methods of dry farming are susceptible of improvement. In 1908 the Department of Agriculture, Bombay, commenced experiments in this connection at Rahuri in Ahmednagar district which has an average rainfall of about 20 inches. These experiments have since been transferred to a plot near Ahmednagar for more convenient supervision. They are being conducted on the following lines :—(1) to increase the capacity of the soil to store water, (*a*) by deeper and more thorough preparatory tillage, (*b*) by packing the soil by sub-soil packer and heavy roller, (2) to prevent evaporation by better inter tillage, (3) to allow the individual plant to get more water per plant by thinner seeding and wider spacing and thus admit of more nearly perfect development, (4) to assist germination by (*a*) moistening seed, (*b*) firming after planting, (5) to attempt to increase the amount of stored water by bunding and impounding. Deeper ploughing before the rains for a *rabi* crop has been found to give an increased yield of about 60 per cent. By practising inter-culture every week from sowing time till the plants are too large for passing bullocks between them a substantial increase in the yield was obtained. With the use of the drill 18 inches apart the results obtained were much better than with the 9 inches drill. The increase in the yield by the reduc-

tion of the seed rate to half gave striking results, the yield being increased by 75 per cent. This might be an advantage in localities where grain has a higher value than fodder.

In view of the importance to India of dry farming steps have been taken for the representation of the Government of India on the International Dry Farming Congress of America and the Inspector General of Agriculture has been made Vice-President for the Indian Section of the British Empire with Mr. H. C. Sampson, Deputy Director of Agriculture, Madras, as corresponding Secretary.

7. *Alkali or Reh Lands.*—Alkali or *Reh* lands are very extensive in the Punjab, United Provinces, and parts of the Bombay Presidency.

From the vast area affected in the Punjab, the reclamation of alkali land is a problem of primary importance in that province. The cause of the accumulation of salt in the soil of these plains appears to be the excessive weathering to which it is subject by the wide ranges of temperature combined with a slight rainfall and a lack of well defined drainage. The most important feature at present seems to be its persistence and even reappearance in canal irrigated areas. The local department, therefore, proposes to confine its investigations to the problem as it exists in the Chenab Colony and to institute irrigation and drainage experiments, as soon as the Agricultural Chemist is in a position to co-operate from the laboratory.

In the United Provinces, the problem is said to present a somewhat different aspect to most other *Usar* lands in India in that the greater portion of the affected area contains sodium carbonate, which causes certain soils to become impervious to water. The subject is being studied by the Imperial Agricultural Chemist in collaboration with Mr. Burt, and this work has already been noticed in the Section dealing with the Imperial Agricultural Chemist's work. It is, however, evident that in many cases the accumulation of salts is due to evaporation of moisture on the surface of the soil by which the salts are deposited and that this is aggravated by the high water level of the country. If this were lowered and a system of drainage introduced large areas could be saved.

In the Bombay Presidency, the development of salt lands results from the reaction of saline irrigation water on the black cotton soil of the Deccan. On such soils an improved system of dry cropping might be tried with advantage. Dr. Mann's study of the methods for dealing with the question of the development of salt and barren lands in the Nira Valley irrigation area has been practically completed and a bulletin on the subject is now in press. In that bulletin Dr. Mann shows that the development of the salt barren area is entirely or almost entirely due to the rise in the sub-soil water to an unhealthy extent, caused by the impossibility of the seepage water from the canal getting away by the natural drainage channels. There is already much salt even in the good land of that tract which demands the application of very much larger quantities of manure and water than would be otherwise required and there is reason to fear that the barren area may go on increasing. Accordingly in this bulletin a description is given of successful and possible methods of prevention and reclamation. In Sind, the *kalar* salts are soluble, *i.e.*, can be removed by irrigation and drainage. The reclamation of alkali lands in that province can be effected, in Mr. Henderson's opinion, by a thorough system of irrigation and drainage followed by a suitable cropping programme. The reclamation experiments after Egyptian methods on the Daulatpur farm have proved the soundness of this opinion. Of the 400 acres levelled and canalised, over 200 have been reclaimed and are giving a full crop of cotton. The introduction of leguminous crops and the practice of green manuring is also desirable on the semi-kalar lands of the Jamrao Canal area. Of restorative crops, Barseem (*Trifolium alexandria*) seems to be the best and is certainly a success in Sind. It is not difficult to grow provided there is water. It also gives an excellent yield of fodder. In connection with this subject attention is drawn to an article on a " Problem in Agriculture " by Mr. J. Mollison which has appeared in the October number of the Agricultural Journal of India, 1910. The *Reh* problem in India was referred to a Committee of the Board of Agriculture this year. The Committee were much impressed with the fact that some irrigation schemes have been carried out in the past without due considera-

tion to drainage. They understood that this matter was now receiving attention but they considered that this aspect of the case could not be emphasised too strongly in dealing with new schemes and in remodelling canal systems. It was a case in which the co-operation of the Irrigation with the Agricultural Department was likely to lead to useful results. The Committee recognised that the problem is an economic one and were disposed to advise that this aspect be kept strictly in view in attacking it. As there is no reliable information with reference to the conditions regulating the accumulation and removal of saline matter, the Committee urged the desirability of reclamation experiments being accompanied by suitable scientific investigation when possible.

8. *Special Enquiries.*—Under this heading the most important are the *rab* investigations which have been going on in the Bombay Presidency since 1904. *Rab* is the name given to the application of loppings of wood, cowdung, or other materials which are burned on rice seed beds as a preparatory treatment. This practice prevails in the Konkan districts of the Bombay Presidency where the rainfall is from 50 to 200 inches. As this system is objectionable from the injurious effect of ruthless lopping of forest trees and the waste of nitrogen available in cowdung, investigations were undertaken by Dr. Mann in collaboration with Mr. Knight to find out firstly what is the beneficial action of the *rab* and secondly a substitute for *rab*. The first results of Dr. Mann's study of the matter are now ready for publication. It has been proved that about two-thirds of the effect of the *rab* treatment can be obtained by the heating alone. The action of heat (1) alters the number and proportion of the different bacteria in the soil, (2) makes considerable amounts of organic nitrogenous matter in the soil soluble and (3) improves the physical condition of the land. It may be noted that these results are in accordance with recent European researches on the subject of heating soils.

Different treatments with cowdung, earth saturated with urine from the byres, poudrette, oil-cake, nitre and soil pulverization were tried with the object of finding out effective and economical substitutes for *rab*. As a result of these experiments

the following substitutes have been recommended per *guntha* of seed bed :—

(1) 500 lbs. well rotted cow manure ploughed in and thoroughly mixed with the soil if possible immediately after the harvest.
(2) 50 lbs. of oil-cake thrown broad-cast and thoroughly ploughed before sowing.
(3) 200 lbs. of poudrette well mixed with the earth.
(4) 1,000 lbs. of urine earth.
(5) 20 lbs. of crude nitre.

In Burma the Department is dealing with a problem somewhat akin to that of *rab*, *viz.*, that of discovering some method whereby the wasteful system of cutting down forest to perform temporary cultivation, as practised in the hill tracts of the province, may be stopped or improved. These cultivations, which last for a year or two only, are known as " taungyas." Various methods are pursued by the people who adopt this mode of living, and the Department has approached the problem by making a survey of different kinds of taungyas with a view to discovering the cause which prevents the cultivation from being permanent.

In Madras Presidency successful efforts are being made to bring into more extended use the system of transplanting single seedlings of rice. The seed rate under this system on the Samalkota farm is 6 lbs. whereas the ordinary cultivator's seed rate is from 70 to 140 lbs. In view of the very large areas under paddy in that presidency the introduction of this system is of special importance particularly because a very large amount of seed which is at present wasted would be left for food. The advantages of this system have been demonstrated in the Godaveri district where it will be followed by numerous cultivators next year. It has also been demonstrated at Palur, Taliparamba, Nundyal and in the villages round Hagari, and is being carried out on thousands of acres this season in Tanjore where many cultivators have reduced their seed rate from 40 to 50 Madras measures to 3 Madras measures per acre. It is also being introduced in Tinnevelly and South Arcot. At

Coimbatore the ryots in the vicinity of the farm have reduced their seed rate by one-half after seeing this method practised on the farm.

The Government of the Punjab have sanctioned the employment of an experienced date grower from Basrah for three years with a view to the introduction of improved methods of date cultivation in the south-west of the Punjab where climatic conditions are suitable for date cultivation. It is proposed to import suckers of the best Persian Gulf varieties and plant them in the Multan and Muzaffergarh districts. Although the date crop is of great economic value in south-west Punjab, forming an important part of food of the people, the date trees are allowed to grow absolutely wild. With care in planting good varieties, in propagating from suckers instead of from seeds, in fertilising the flowers of female plants artificially, in general cultivation and in preserving the fruits, it is hoped to be able to greatly improve the quality of the produce and to make the crop a valuable asset to the province. It will be some years before suckers from the improved varieties will be available for distribution or sale. In the meantime the Department proposes to test in local date groves improved methods of cultivation and of preserving fruit and also to study the utilization of the bye-products of the date palm.

Under a description of the work of the Imperial Economic Botanist mention has been made of special fruit experiments to be undertaken from this year in Baluchistan with a view of developing a fruit industry for India on modern lines.

9. *Sericulture.*—Considerable developments have taken place in the operations directed towards the improvement of silk in several provinces. In Bengal, the Central Nursery is situated at Berhampur which is the head-quarters of this industry. A number of small nurseries are situated in the chief cocoon-rearing centres of the Murshidabad, Birbhum and Midnapur districts. Disease-free seed is being reared and distributed as widely as possible in the silk-rearing districts through the agency of village nurseries. There was no outbreak of disease amongst the worms reared according to the Pasteur system, from cocoons microscopically examined. The seed of the nurseries is

growing steadily in popularity. To meet the increasing demand, two more rearing-houses were added to the Berhampur Central Nursery. Six new nurseries were built during the year. Three of these are in the Murshidabad district, two in Birbhum and one in Ghatal. Altogether there are now 18 nurseries in Bengal.

The experiments conducted with Italian mulberry in the Central Nursery were successful, and the experiments in the cold storage of seed and cocoons also proved a success. By the cold storage method the Superintendent has been able to prevent the spread of disease, especially pebrine. By this means also, it has been found possible to delay the cutting out of the silk worms and so to regulate the supply of seed according to demand. Worms produced under these conditions look stronger and healthier than those reared in the ordinary way. An important development is the institution of a class for the training of the sons of *bonâ fide* rearers at the Central Nursery, Berhampur. A complete course in the selection of seed, the rearing of worms and the growing of mulberry is being given.

In Eastern Bengal and Assam, a central rearing station has been established at Mirganj. A mulberry plantation of about 60 bighas has been attached to this station and includes, besides the Bengal bush mulberry, some European mulberry trees which have been successfully grown. The nursery has been equipped with three rearing houses and one seed house. Some experiments were made with *Var* seed newly imported from France and with a cross between French and Japanese worms of which the seed was obtained from France through Messrs. Anderson, Wright & Co., and also with a cross between French and Nistri worms produced at Mirganj. All the crosses have been reared on the Bengal mulberry leaf and quite good results obtained. There are two other nurseries in the Rajshahi district, *viz.*, one at Baneswar and the other at Kharkharie. Some work was done during the year in the way of instructing village rearers in their own homes in the methods of disinfecting their rearing houses. The Department, in its endeavour to revive the silk industry in the province on sound principles, is availing itself of the advice of the Imperial Entomologist.

In the Punjab about 200 ounces of disease-free eggs were obtained by a private gentleman from France, through the local Department of Agriculture, and distributed in the Gurdaspur district, where sericulture has persisted as a profitable industry even with diseased seed and defective methods. The experiment, however, did not meet with success owing to want of care on the part of the rearers. The same gentleman is purchasing 300 ounces of eggs this year through the Department and is arranging to reel his silk by improved methods. Private trials are being made in Hoshiarpur and Jhelum. The Department proposes to persevere in the submontane tracts. The Irrigation Department are assisting by planting mulberries along the upper reaches of canals in Gurdaspur, Ludhiana, and Ambala. Seed and cuttings of Italian mulberry are being tried as well as cuttings of Mysore and Philippine mulberry. It is also proposed to experiment with Japanese and Bengal bush mulberry at Lyallpur. The Department will give practical demonstrations of rearing in selected centres next spring.

The nursery in connection with the *tussar* farm at Arsoda in the Chanda district of the Central Provinces has now been worked for over two years. It was intended that the distribution of good seed from this nursery would eradicate the disease to which the decay of the local industry has been attributed. The results, however, have not been successful. Seed from Bilaspur and Chaibassa proved inferior to that obtained locally and even the local breed deteriorated after the first generation. The failure is attributable to the fact that the female moths do not remain under control but pair during flight with wild males. So long therefore as wild males have access to the farm and cannot be kept out it will remain impossible to prevent them from introducing the disease afresh. The work may have to be discontinued. The Bengal tussar work at Chaibassa also may have to be given up as the unavoidable influence of wild males results in cross breeds of unknown value and leads to disease.

The cultivation of eri-silk has been continued at Pusa. Every process from rearing the worms to weaving the cloth is being conducted in the silk-house. The demand for eri-seed

from every part of India, except Assam was far in excess of the supplies available. The industry is most extensive at present in Tirhoot, Bhagalpur and Patna, the three divisions nearest to Pusa, but it is being tried also in Malabar, Dharwar, West Coast, Gujarat, Kathiawar, Sind, Patiala, Rohilkhand, Betul, Chanda and Murshidabad. The Salvation Army has also taken it up at Bangalore and elsewhere. The further extension of this industry depends upon the growth of organisations for collecting and selling small quantities of cocoons from the rearers. Trials are being made at Pusa with hybrids between *Attacus ricini*, the eri and *Attacus cynthia*, the wild form, in the hope of producing a more robust race. The disease of eri worms is being investigated by Mr. H. Maxwell-Lefroy in collaboration with the Imperial Agricultural Bacteriologist and trials are being made of the various varieties of castor for feeding the worms. Mulberry silk cultivation was continued at Pusa mainly to determine how far it can be economically worked, either to provide raw silk or to supply cocoons. All available varieties have been collected at Pusa for hybridising. The rearing of the best Italian and French varieties has been very successful. The rearing of the ordinary Bengal varieties has shown that they are not worth cultivating in Behar and that the continuance of their cultivation will only end in the failure of the industry. The cultivation of a hybrid between the European univoltine worms and the Bengal multivoltine is giving good results.

An outbreak of disease among the worms, coupled with the high price of mulberry leaf, which the people are unwilling to sell as its periodical cutting interferes with the fruit which is their food in winter, made silk industry in the Kelat State unprofitable and it has been decided to suspend further operations for four or five years. It is hoped that the growth of State-owned mulberry trees which have already been planted will enable operations to be renewed.

The Baroda State continued to carry on sericultural operations in their territory. The sites selected in the Tapti valley were found unsuitable and the operations have been transferred

to Baroda and Navsari. The Imperial Department of Agriculture lent the services of two expert spinners to teach improved methods of spinning to the servants of the Baroda Sericultural School. The Baroda Agricultural Department continued to distribute eggs among the ryots and also to make arrangements for selling the produce. With a view to make the industry popular the processes connected with the manufacture of eri silk were exhibited at several fairs in the State and in the adjoining British territory.

10. *Poultry-Breeding.*—This work is now being conducted on a fairly large scale at Pusa. The stock consists of 18 pens of fowls, nearly all of pure breeds, one pen of Mammoth Bronze Turkeys, and one flock each of Embden geese and Aylesbury ducks. The object is to supply at reasonable prices fresh blood of imported strains to provincial agricultural farms and private individuals, who are unable to afford the expense and risk of direct importation. This is effected either by egg distribution or by sale of birds. The price of eggs is Rs. 6 a dozen, and of birds Rs. 30 for an adult trio, and Rs. 16 for half-grown birds. The eggs are sent by post or by rail in boxes, specially made for the purpose, but this mode of distribution has not been, by any means, successful. The percentage of successful incubation from eggs transmitted by post or by rail was extremely low, so low that the method had to be discontinued. The failure is probably mainly attributable to rough handling in transit, and the length of the journeys which have to be undertaken.

It was found that fowls could be successfully sent by rail, even on long journeys such as to Madras or Burma. Most of the provincial departments have had birds supplied, but the results have shown so far only varying success. This was only to be expected when the great variations in soil and climate in the various provinces are taken into consideration. So far the best success has been obtained with Partridge Wyandotte, White Wyandotte, White Orpingtons and Barred Plymouth Rock, while Mammoth Bronze Turkeys have also done well. Four pens of first crosses between Indian and European breeds have been established and the economic results of each cross are being

studied at present. It is proposed shortly to eliminate such European breeds as have proved themselves unsuited to Indian conditions and to substitute for them such indigenous breeds as seem likely to give good results under rigorous selection.

In Eastern Bengal and Assam, poultry breeding experiments are carried out on the central farm at Dacca under the personal supervision of Mr. A. A. Meggitt. The experiments tend to show that the Chittagongs are more robust and better able to withstand heat than Black Langshans. The same breed has also been found to be most satisfactory in the Lushai Hills. Langshans and Orpingtons, while good layers, are delicate and more liable to disease. But the Chittagong breed is capable of improvement by crossing with the above kinds. During the year, the Government of the United Provinces of Agra and Oudh entered into partnership with Colonel Ward, an expert, in a poultry farm at Haldwani. The subsidy to Rampur State poultry farm has, at the same time, been discontinued as it is considered that the Haldwani farm will for the present meet the needs of the province. In the Punjab a lease of land on favourable terms has been given to a private gentleman for a poultry farm near Lahore. In the Central Provinces the rearing of imported poultry has proved a failure, the stock having been tried both at Hoshangabad and Nagpur without success. On the whole there are indications that poultry farming on a commercial scale is gaining in popularity in India, but it would also appear that work in the selection and improvement of indigenous breeds rather than the importation of foreign types is called for and is likely to be beneficial, and attention to this aspect of the subject will be given in future.

11. *Agricultural Education.*—There are now six agricultural colleges in working order in India, *viz.*, at Poona, Coimbatore, Nagpur, Cawnpore, Lyallpur and Sabour in addition to the Central Agricultural College at Pusa which provides for the higher training of students who pass out from these colleges. Out of the students admitted at the Agricultural College, Pusa, last year, nine continued their course and of these seven left during the year after the completion of their training, and one was recalled to his province before the expiry of his term.

Four new students were admitted during the year, *viz.*, one each in Chemistry, Mycology, Entomology and Agriculture. In the short practical courses in agriculture, fruit growing, silk-culture, lac cultivation, cattle-breeding and the like, 39 students were admitted, some of whom took up more than one subject.

Of the students who were deputed by the Bengal Government to the Cornell University in America for training in agriculture, the last two returned during the year. One of them is now employed in the Agricultural Department of that province. It is not at present proposed by the Bengal Department to send any more students to America. The Agricultural College at Sabour was opened for training purposes in November. In the first year, it is proposed to admit some 20 students of whom one-third will come from Eastern Bengal and Assam. The question of improvement of agricultural education in schools was referred by the Bengal Government to a Board of Examiners, consisting of the Director of Agriculture, Deputy Director of Agriculture, and the Principal of the Agricultural College. The report of the Board is now under the consideration of Government. The practice of training sons of cultivators at the experiment stations was continued during the year, principally at the Cuttack farm.

Good progress has been made by the agricultural college at Cawnpore. It has been decided to levy fees from students for attending that college. A governing body for this college has been constituted. This includes the officers connected with the college and representatives of the Department of Public Instruction, as well as two non-official members.

The college at Lyallpur was opened in September 1909, with a class of 16 students. This year 24 students have been admitted.

During the year the work of the Poona College was transferred from Kirkee to the portion of the new buildings to be occupied ultimately by the Physics and Chemistry sections. Later a further wing was occupied and it is expected that the main block will be ready by May, 1911. As a result of representations made by the University Examiners, a Committee was formed in 1909, to modify the syllabus of the Agricultural course

of the Bombay University. The Committee's report, with slight modifications, has been given effect to by the Senate, and the result has been a marked improvement in the usefulness of the course. A short course for farmers and landowners' sons, of a thoroughly practical nature, has been instituted, and the attendance and class of men who are being received, give promise of its filling a much felt want. The total number of students at the College has shown a gradual increase since 1906, and at the end of the present college year 110 students were in attendance. The large number was of men qualifying for the University degree in agriculture. In addition to these there were others who took the courses for the degree but did not proceed to it owing to their not having passed the previous examination or its equivalent. These, if successful, are eligible for the diploma of the Agricultural College. Lastly there were the short course students above mentioned. Occasionally odd students, who have come to study some one special branch, are taken on. Out of 39 students who sat for the Bachelor of Agriculture degree the very gratifying result of 36 passes was obtained. During the year nine scholarships tenable for four years were granted to matriculates belonging to the agricultural classes. It is satisfactory to know that of the college graduates a considerable number are returning to the management of their own lands.

In addition to the instruction given at the college there is a two years' vernacular course at a new school in Poona for the sons of *patils* and substantial landholders and short courses on the farms in special subjects such as seed selection. It is also proposed to have a vernacular agricultural school for Sind with an 18 months' course. The age of the students intended for the latter school will be from 16 to 21, and they will be specially selected from the land-holding and cultivating classes. The object of this school will be to enable students (1) to improve cultivation on their own lands, (2) to manage estates for Zamindars, and (3) to serve in the Agricultural Department. The initial expenditure on the school is estimated at Rs. 6,000, and the recurring expenses at Rs. 2,000. This venture is an important educational experiment which will be watched with much interest.

At Nagpur, where the college still suffers from want of accommodation, teaching is in progress but the buildings are not expected to be completed before two years are over. The number of students admitted during the year was slightly below the number admissible. This is mainly due to the scarcity of local students. It is proposed to admit such non-matriculates as can pass the test held by the Principal, the test prescribed being equal to the Matriculation standard. It is satisfactory to note that the examination results during the year were particularly good in practical agriculture.

The Agricultural College at Coimbatore was opened on the 14th July 1909, by His Excellency Sir Arthur Lawley, Governor of Madras. It has been found that although the full number of students was admitted each term a certain number left before the end of the term and steps are being taken to safeguard the college against this in future.

The question as to how the Agricultural Department might co-operate with the Education Department in (*a*) the improvement of the preliminary training of boys likely ultimately to enter Agricultural Colleges or to be engaged in agricultural pursuits and (*b*) their scientific and practical training at Pusa and provincial colleges was referred to the Board of Agriculture for consideration and report. The Committee thought that the Agricultural Department might offer its services to the Education Department to take part in supervising the courses of instruction given at the training institution to primary teachers and might be invited to make periodical inspection of the teaching in Nature study. They thought that the co-operation proposed might be of assistance in preventing the classes at the training schools from being misdirected towards the object of providing a course of instruction in agriculture or demonstrating particular agricultural improvements. The Committee were of opinion that for the boys who are to enter agricultural colleges, it is not an advantage, but on the other hand a positive disadvantage, that they should previously have received at school instruction in a course of agriculture. The Committee also thought that the requirements of the agricultural colleges would best be met if the students before entering them had

received at school a good general education including Nature study, drawing, and manual training and including also a grounding in the rudiments of some science, preferably Botany or Chemistry taught practically.

12. *Publications.*—During the year 1909-10, the Imperial Department of Agriculture issued six bulletins and eleven Scientific Memoirs on different subjects. The Agricultural Journal of India and the Scientific Memoirs were in greater demand both in India and foreign countries, the learned and other societies of the latter having evinced a greater desire to have these in exchange for their publications. Both Imperial and Provincial experts liberally helped these publications by their contributions. Contributions were also received for the Agricultural Journal of India from other Government officials and private persons.

Useful articles and notes published in the Agricultural Journal of India are now utilised by the provincial agricultural associations for circulars and leaflets issued by them for the benefit of the agriculturists.

With reference to the more important publications Mr. Lefroy's " Indian Insect Life " has been well received, both by the press and the public, and nearly three-fourths of the first edition have been already sold out. A Bengali translation of his " Indian Insect Pests " profusely illustrated, has been made by Mr. C. C. Ghosh, B.A., Second Assistant to the Imperial Entomologist, and has been published at the expense of the Government of Bengal.

Mr. and Mrs. Howard's comprehensive publication on " Wheat in India " published during the year is largely in demand by the Provincial Departments of Agriculture and others interested in the wheat trade in India. The same authors have also published important Memoirs on Indian fibre plants and the Indian tobaccos.

Five bulletins were published during the year by the Department of Agriculture, Bombay. Of these one on kalar in Sind by Mr. Henderson, N.D.A., N.D.D., and the other on the salt lands of the Nira Valley by Dr. H. H. Mann, D.Sc., and V. A. Tamhane, L. Ag., give practical suggestions for dealing with salt

lands in Sind and in the Deccan. The bulletin on an examination of the seed supply of the Broach District by Mr. G. D. Metha, L.Ag., B.A., N.D.A., N.D.D., forms the first instalment of a systematic study of the seed sown in the Bombay Presidency. Thirteen leaflets, all dealing with simple matters in which the department is prepared to make definite recommendations, were also published. Besides these, three Marathi publications on (1) Groundnut Cultivation in Konkan, (2) Cultivation of fruit trees and (3) diseases of cattle were privately published.

The Department of Agriculture, Madras, published two bulletins on (1) the cattle of Southern India and (2) improvements in paddy cultivation at Sivagiri. The Agricultural Calendar was published as usual in English and two vernaculars and was widely distributed. Numerous vernacular leaflets were published on subjects on which the Department had to offer some definite advice.

The Bengal Department published four leaflets in English and the vernaculars and also a note on Sericulture in Bengal.

In Eastern Bengal and Assam the Department issued during the year a bulletin on the Poultry Industry and a leaflet on the preparation and packing of specimens of plants and insects. The latter is a reprint from the leaflet issued by the Bengal Department. A useful departure has been made in publishing an annual issue of the Year-book of the Department.

In the United Provinces the Department published in English a pamphlet on " Northern India as a Market for Agricultural Machinery " for the assistance of intending competitors at the United Provinces Exhibition. Three vernacular pamphlets were also issued on (1) cultivation of lucerne, (2) rabi harvesting, the use of reaping machines and winnowers, and (3) improved methods of growing maize. The Department patronizes three vernacular journals.

In the Punjab the Department published a bulletin on the cultivation of stronger and more valuable wheats for export from the Punjab, reference to which has already been made under wheat.

During the year under review a bulletin on the annual variations in the character of Central Provinces wheats was published by Mr. G. Evans, B.A., Deputy Director of Agriculture, Northern Circle, Central Provinces.

The Department of Agriculture, Burma, published during the year seven cultivators' leaflets as also the report on the Agricultural Survey of the Myingyan District. A similar publication on the Sagaing District is in the press.

A complete list of the publications of the Imperial and Provincial Departments during the year, is given as an appendix to this report.

13. *Board of Agriculture.*—The sixth meeting of the Board of Agriculture was held at Pusa from the 21st to 26th February 1910, and was attended by 36 members and 23 visitors as against the same number of members and 8 visitors in the preceding year. The subjects for discussion were :—(1) the programmes of work of the Imperial and Provincial Departments of Agriculture, as well as those of Mysore, Baroda and Kashmir States; (2) the most economical use of the manures available in India; (3) the *Reh* problem in India; (4) the best means of supplying improved agricultural implements to cultivators; (5) the oil-pressing industry and the best means of extending it; (6) cattle breeding and value of cattle shows in India; (7) co-operation between the Educational and Agricultural Departments with reference to the improvement of the preliminary training of boys likely ultimately to enter agricultural colleges or to be engaged in agricultural pursuits; (8) the best means of bringing the results of experimental work in agriculture to the notice of cultivators; (9) agricultural engineering, particularly in regard to well-boring and well-irrigation, the progress made in agricultural engineering in the different provinces and the necessity for the services of agricultural engineers; and (10) the style in which the programmes of the provincial Agricultural Departments should be submitted to the Board. All the subjects, except No. 6, were first referred to Committees appointed for the purpose of discussing them in details and were then discussed by the Board along with the reports of the Committees. The reports of the Committees and the rulings of the Board thereon

are contained in the published Proceedings of the Board. In dealing with the subjects (2) and (5) in particular the Board recommended that every province should prepare full notes on the manures available and on the experience acquired in their use, and what is being done and could be done for the popularisation of the use of oil-cakes, for consideration at its next meeting. While the Board appreciated the advantages gained by the opportunities afforded by its meetings for interchange of opinion, it considered that it would be sufficient if, in future, the meetings are held in every alternate year instead of annually as heretofore. It has therefore been decided to hold the next meeting in February 1912. The report of the Committee appointed to consider the subject of the best means of bringing the results of experimental work in agriculture to the notice of cultivators as passed by the Board, has been separately published.

14. *Expenditure.*—The expenditure incurred by the Imperial Department of Agriculture during the year amounted to Rs. 4,23,723 as detailed below, against the expenditure of Rs. 4,30,714 during 1908-09 :—

	Rs.
Inspector General of Agriculture	1,11,295
Director, Agricultural Research Institute, Pusa . .	93,231
Chemical Section	29,860
Mycological Section	26,769
Entomological Section	48,593
Second Entomological Section	11,199
Botanical Section	32,956
Bacteriological Section	6,586
Agricultural Section	63,234
TOTAL .	4,23,723

There is thus a decrease of Rs. 6,991 as compared with the expenditure of the previous year. The total includes special grants placed at the disposal of the Inspector General of Agriculture for such special agricultural investigations as he may

think fit to initiate or encourage. The principal heads of expenditure from this amount are as follows :—

	Rs.
(1) Grant-in-aid to the Indian Tea Association . .	15,000
(2) Poultry breeding experiments	3,890
(3) Paid to Behar Indigo Planters' Association for pay of Flax Expert	2,750
(4) Experiments in connection with the milling and baking qualities of Indian wheats . . .	1,766
(5) Sericulture experiments at Pusa	846
(6) Purchase of seeds	415
(7) Purchase of cows for Pusa	500
(8) Fruit experiments at Pusa	110
(9) Paid to the Director of Agriculture, Bombay, for *kalar* land experiments in Sind	3,100
(10) Wheat testing experiments	101
TOTAL .	28,478

The expenditure incurred by the Provincial Departments of Agriculture during the year is detailed below :—

	Rs.
Bengal	3,66,268
United Provinces	4,22,000
Punjab	2,94,713*
Bombay	6,50,855†
Central Provinces	2,05,657
Madras	2,69,961
Burma	1,36,639
Eastern Bengal and Assam	2,85,125
TOTAL .	26,31,218

* This includes Rs. 88,900 expenditure on public works.

† This includes Rs. 1,19,974 spent for the Agricultural College building, Poona.

APPENDIX

List of Agricultural Publications in India during 1909-10.

No.	Title.	Author.	Where published.
	General Agriculture.		
1	Report on the Progress of Agriculture in India for 1907-09. Price 6 annas.	Inspector General of Agriculture in India.	Government Printing, India, Calcutta.
2	Report of the Agricultural Research Institute and College, Pusa (including the report of the Imperial Cotton Specialist, for 1907-09). Price 4 annas.	Ditto	Ditto.
3	Proceedings of the Board of Agriculture in India held at Nagpur in February, 1909, with appendices. Price 8 annas.	Ditto	Ditto.
4	Proceedings of the Board of Agriculture in India held at Pusa on the 21st February, 1910, with appendices. Price 8 annas.	Ditto	Ditto.
5	Agricultural Journal of India, Vol. IV, Parts 3 and 4, Vol. V, Parts 1 and 2 (Annual subscription Rs. 6).	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
6	Note on the Extension of Cultivation of Fibre Plants, Bulletin No. 15 of the Agricultural Research Institute, Pusa.	Inspector General of Agriculture in India.	Government Printing, India, Calcutta.
7	Prospectus of the Agricultural Research Institute and College, Pusa.	Agricultural Research Institute, Pusa.	Ditto.
8	Short Courses in Practical Agriculture and other allied subjects at Pusa.	Inspector General of Agriculture in India.	Secretariat Press, Nagpur.
9	Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Departments.	Board of Agriculture in India for 1909.	Government Printing, India, Calcutta.
10	Second Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Departments. Price 2 annas.	Ditto for 1910	Ditto.
11	Wheat in India, its production, variety and improvement. Price Rs. 5.	A. Howard, M.A., and G. L. C. Howard, M.A.	Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
12	Area and Yield of certain principal crops in India for various periods, from 1894-95 to 1908-09. Price 4 annas.	Commercial Intelligence Department of the Government of India.	Government Printing India, Calcutta.
13	The Agricultural Ledger, 1908-09, No. 6. Indian Pens. Price 2 annas or 2*d.*	I. H. Burkill, M.A.	Ditto.
14	Indigo Reports	Rawson and Bergtheil .	Baptist Mission Press, Calcutta.
15	Report of the Indigo Research Station, Sirseah, for 1909-10.	C J. Bergtheil . .	Ditto.
16	Sixth Report of the Sirseah Sub-Committee to the Directors of the Behar Planters' Association, for the year ending 31st March, 1910.	Behar Planters' Association, Muzafferpore.	Ditto.
17	Annual Report of the Department of Agriculture, Bombay, for 1908-09. Price 8 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
18	Season and Crop Report of the Bombay Presidency for 1908-09. Price 7 annas.	Ditto	Ditto.
19	Annual Report of the Surat Agricultural Station for 1908-09. Price 14 annas.	Ditto	Ditto.
20	Annual Report of the Dharwar Agricultural Station for 1908-09. Price 12 annas.	Ditto	Ditto.
21	Annual Report of the Dhulia Agricultural Station for 1908-09. Price 12 annas.	Ditto	Ditto.
22	Annual Report of the Nadiad Agricultural Station for 1908-09. Price 10 annas.	Ditto	Ditto.
23	Annual Report of the Manjri Agricultural Station for 1908-09. Price 4 annas.	Ditto	Ditto.
24	Annual Report of the Lonavla Agricultural Station for 1908-09. Price 3 annas.	Ditto	Ditto.
25	Annual Report of the Dohad Agricultural Station (Muwalia) for 1908-09. Price 8 annas.	Ditto	Ditto.
26	Annual Report of the Kirkee Civil Dairy for 1908-09. Price 4 annas.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
27	Annual Report of the Agricultural College Station, Poona, for 1908-09. Price 4 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
28	Annual Report of the Ganeshkhind Botanical Station for 1908-09. Price 5 annas.	Ditto	Ditto.
29	Annual Report of the Bassein Botanical and Agricultural Station for 1908-09. Price 4 annas.	Ditto	Ditto.
30	Annual Report of the Mirpurkhas Agricultural Station for 1908-09. Price 7 annas.	Ditto	Ditto.
31	Annual Report of the Daulatpur Reclamation Station for 1908-09. Price 8 annas.	Ditto	Ditto.
32	Annual Report of the work done in Sind by the Agricultural Department outside Mirpurkhas and Daulatpur Stations for the year 1908-09. Price 7 annas.	Ditto	Ditto.
33	Night Soil—a Valuable Manure, Bulletin No. 34 of 1909 of the Department of Agriculture, Bombay. Price 4 annas.	G. K. Kelker, Assistant Professor, Agricultural College, Poona.	Ditto.
34	Kalar in Sind. Bulletin No. 35 of 1909. Price 4 annas.	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture in Sind.	Ditto.
35	An Examination of the Seed Supply of the Broach District. Bulletin No. 37 of 1910.	G. D. Mehtra, L. Ag. (Bom.) B.A. (Cantab.), N.D.A., N.D.D.	Ditto.
36	Experiments with the Waterfinder of Messrs. Mansfield & Co., in the Trap Area of Western India.	H. K. Mehta, M.A., B.SC.	Ditto.
37	Poona Gul-boiling Furnace. Leaflet No. 16 of 1909.	Department of Agriculture, Bombay.	Ditto.
38	The Scum Strainer in *Gul* boiling. Leaflet No. 17 of 1909.	Ditto	Ditto.
39	Note on Eri Silk. Leaflet No. 18 of 1909.	Ditto	Ditto.
40	Chaff-cutters, Leaflet No. 21 of 1909	Ditto	Ditto.
41	Guinea Grass, Leaflet No. 22 of 1909.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
42	Preparation of Turmeric for the market, Leaflet No. 23 of 1909.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
43	Groundnuts-cultivation of Spanish Peanuts, Leaflet No. 2 of 1910.	Ditto	Ditto.
44	Groundnut culture in the Konkan, Leaflet No. 3 of 1910.	Ditto	Ditto.
45	Lucerne, a valuable Green Fodder, Leaflet No. 4 of ~~1909~~ 1910.	Ditto	Ditto.
46	A feeding meal from the Scum obtained in *Gul* boiling, Leaflet No. 5 of ~~1909~~ 1910.	Ditto	Ditto.
47	Report on the operations of the Department of Agriculture, Madras, for 1908-09. Price 6 annas.	Department of Agriculture, Madras.	Government Press, Madras.
48	Season and Crop Report of the Madras Presidency for 1908-09. Price 4 annas or 6*d*.	Board of Revenue, Madras.	Ditto.
49	Scientific Report of the Hagari Agricultural Station for 1908-09. Price Re. 1.	Department of Agriculture, Madras.	Ditto.
50	Scientific Report of the Bellary Agricultural Station for 1908-09. Price 2 annas.	Ditto	Ditto.
51	Scientific Report of the Nandyal Agricultural Station for 1908-09. Price 6 annas.	Ditto	Ditto.
52	Scientific Report of the Koilpatty Agricultural Station for 1908-09. Price 3 annas.	Ditto	Ditto.
53	Scientific Report of the Samalkota Agricultural Station for 1908-09. Price 10 annas.	Ditto	Ditto.
54	Scientific Report of the Palur Agricultural Station for 1908-09. Price 3 annas.	Ditto	Ditto.
55	Scientific Report of the Taliparamba Agricultural Station for 1908-09. Price 2 annas.	Ditto	Ditto.
56	Cattle of Southern India, Bulletin No. 60 of the Department of Agriculture, Madras. Price Rs. 2.	Lieutenant-Colonel W. D. Gunn.	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
57	Improvements in Paddy cultivation of the home farm at Sivagiri-Tinnevelly District Bulletin No. 61 of the Department of Agriculture, Madras. Price 9 annas (In English, Tamil, Telugu, Malayalam).	J. M. Lonsdale, N.D.A., N.D.D., Agricultural Expert to the Court of Wards, Madras.	Government Press, Madras.
58	Agricultural Calendar for 1910 .	Department of Agriculture, Madras.	Ditto.
59	Uses of the Harrow (in Tamil) .	S. Subramania Iyer .	Ditto.
60	Cotton cultivation (in Tamil) . .	A. R. Trimmuranganathum.	Ditto.
61	Single planting of Paddy (in Tamil)	H. C. Sampson, B.SC., Deputy Director of Agriculture, Madras.	Ditto.
62	Leaflet on Manuring in the Kistna Delta (in Telegu).	W. H. Harrison, M.SC.	Ditto.
63	Leaflet on Groundnut cultivation on the West Coast (in English).	H. C. Sampson, B. SC., F.H.A.S., etc.	Ditto.
64	Leaflet on preparation of Green Ginger in South Canara (in Tamil, Telegu and Malayalam).	J. Saldonha of South Canara.	Ditto.
65	Leaflet on single planting of Paddy (in English, Tamil and Telegu).	H. C. Sampson, B.SC., F.H.A.S., etc.	Ditto.
66	Leaflet on Green Manuring (in Tamil).	Ditto	Ditto.
67	Note on Pepper (in English, Tamil, Telegu and Malayalam).	Dr. C. A. Barber, M.A., D.SC., F.L.S.	Ditto.
68	Note on Cambodia Cotton (in English, Tamil and Telegu),	H. C. Sampson, B.SC., F.H.A.S., etc.	Ditto.
69	Annual Report of the Department of Agriculture, Bengal, for 1908-09. Price 8 annas.	Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
70	Annual Report of the Chaibassa Tasar Silk Rearing Station for 1908-09. Price 5 annas.	Ditto	Ditto.
71	Annual Report of the Dumraon Agricultural Station for 1908-09. Price 8 annas.	Ditto	Ditto.
72	Annual Report of the Burdwan Agricultural Station for 1908-09. Price 4 annas.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
73	Annual Report of the Cuttack Agricultural Station for 1908-09. Price 6 annas.	Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
74	Annual Report of the Bankipur Agricultural Station for 1908-09. Price 4 annas.	Ditto	Ditto.
75	Quarterly Journal, Volume III, Nos. 1 to 4. Price 8 annas per copy.	Ditto	Ditto.
76	Season and Crop Report for 1908-09. Price 9 annas.	Ditto	Ditto.
77	Note on Sericulture in Bengal (not for sale).	Ditto	Ditto.
78	Report on First Wage Census of Bengal (not for sale).	Ditto	Ditto.
79	Agricultural Statistics of Bengal for 1908-09. Price Re. 1.	Ditto	Ditto.
80	Potatoes-cultivation, manuring, varieties, storing and seed supply in Bengal. Leaflet No. 6 of 1909.	F. Smith, B.SC., Deputy Director of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
81	Simple instructions on Arboriculture. Leaflet No. 7 of 1909.	Department of Agriculture, Bengal.	Ditto.
82	Annual Report of the Department of Agriculture, Eastern Bengal and Assam, for the year ending 30th June 1909. Price 8 annas.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
83	Annual Report of the Dacca Agricultural Station for 1908-09. Price 2 annas.	Ditto	Ditto.
84	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1909. Price 2 annas.	Ditto.	Ditto
85	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1909. Price 2 annas.	Ditto	Ditto.
86	Annual Report on the Tropical Plantation at Wahjain for the year ending 30th June 1909. Price 2 annas.	Ditto	Ditto.
87	Annual Report of the Burirhat Agricultural Station for the year ending 30th June 1909. Price 2 annas.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
88	Annual Report of the Shillong Fruit Garden for the year ending 30th June 1909. Price 2 annas.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
89	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June 1909. Price 2 annas.	Ditto	Ditto.
90	Report on the Season and Crops of Eastern Bengal and Assam for the year ending 31st March 1909. Price 8 annas.	Ditto	Ditto.
91	Annual Report of the Agricultural Stations in Eastern Bengal and Assam for 1908-09. Price 12 annas.	Ditto	Ditto.
92	Report on Tea Culture in Eastern Bengal and Assam for the year 1908. Price 8 annas or 9*d*.	Ditto	Eastern Bengal and Assam Secretariat Printing Office, Shillong.
93	Year Book in Bengali of the Agricultural Department of Eastern Bengal and Assam for 1908.	Ditto	Ditto.
94	Year Book in English of the Agricultural Department of Eastern Bengal and Assam, 1317 B. S. Price 2 annas.	Ditto	Ditto.
95	Year Book of Agriculture in Bengali for 1909.	Ditto	Ditto.
96	Supplementary note on Jute in Rotation with Paddy in the same year and its effect on food crops.	Ditto	Ditto.
97	Poultry Industry-Bulletin No. 22 of the Department of Agriculture, Eastern Bengal and Assam.	Ditto	Eastern Bengal and Assam Secretariat Press, Shillong.
98	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1909. Price 8 annas.	Department of Agriculture, United Provinces of Agra and Oudh.	Government Press, Allahabad.
99	Annual Report of the Cawnpore Agricultural Station for the year ending 30th June 1909. Price Re. 1.	Ditto	Ditto.
100	Annual Report of the Jalaun (Orai) Agricultural Station for the year ending 30th June 1909. Price 8 annas.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
101	Annual Report of the Aligarh Agricultural Station for the year ending 30th June 1909. Price 8 annas.	Department of Agriculture, United Provinces of Agra and Oudh.	Government Press, Allahabad.
102	Annual Report of the Partabgarh Agricultural Station for the year ending 30th June 1909. Price 8 annas.	Ditto	Ditto.
103	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1908-09. Price 8 annas.	Ditto	Ditto.
104	A Pamphlet on Northern India as a Market for Agricultural Machinery.	Ditto	Ditto.
105	A Pamphlet on Rabi Harvesting, the use of Reaping Machines and Winnowers (in Hindi and Urdu).	Ditto	Naval Kishore Press, Lucknow.
106	A Pamphlet on inproved Methods of Growing Maize (in Hindi and Urdu).	Ditto	Ditto
107	A Pamphlet on the cultivation of Lucerne (in Hindi and Urdu).	Ditto	Ditto.
108	Report on the operations of the Department of Agriculture, Punjab, for the year ending 30th June 1909. Price 3 annas.	Department of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
109	Annual Report of the Lyallpur Agricultural Station for 1908-09. Price 5 annas.	Ditto	Ditto.
110	Report on the Season and Crops of the Punjab for 1908-09.	Ditto	Ditto.
111	List of Improved Agricultural Implements recommended by the Department of Agriculture, Punjab, (Revised).	Ditto	Ditto.
112	The cultivation of stronger and more valuable Wheats for export from the Punjab.	W. C. Renouf, I.C.S., Director of Agriculture, Punjab.	Ditto.
113	Report on the working of the Department of Agriculture, Central Provinces for the year 1908-09. Price Re. 1.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
114	Report on the Agricultural Stations in the Central Provinces for the year 1908-09. Price Re. 1.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
115	Season and Crop Report of the Central Provinces for the year 1908-09. Price 8 annas.	Department of Land Records, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
116	Annual variations in the character of Central Provinces Wheats-Bulletin No. 3 of 1909 of the Department of Agriculture, Central Provinces.	G. Evans, B.A. (Cantab.), Deputy Director of Agriculture, Central Provinces, Northern Circle.	Ditto.
117	Agricultural Gazette. A monthly publication. Price 2 annas per copy.	D. Clouston, M.A., B.SC., Deputy Director of Agriculture, Central Provinces.	Ditto.
118	Nagpur Agricultural College Calendar, 1909-10.	Department of Agriculture, Central Provinces.	Ditto.
119	Report on the operations of the Department of Agriculture, Burma, for 1908-09. Price 4 annas.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
120	Scientific Report of the Agricultural Station, Mandalay, for the year 1908-09.	Ditto	Ditto.
121	Season and Crop Report of Burma for the year ending the 30th June 1909.	Commissioner of Settlements and Land Records.	Ditto
122	Agricultural Surveys No. 1, Myingyan District.	A. Mckerral, M.A., B.SC., Deputy Director of Agriculture, Burma.	Ditto.
123	The preservation of mixtures of Sesamum and Groundnut oil. Cultivators' Leaflet No. 18.	Department of Agriculture, Burma.	Ditto.
124	Sun-Hemp cultivation. Cultivators' Leaflet No. 20.	Ditto	Ditto.
125	Cultivators' Leaflet No. 21. The Seed Drill.	Ditto	Ditto.
126	Cultivators' Leaflet No. 22. The Angle Harrow.	Ditto	Ditto.
127	Cultivators' Leaflet No. 23. The Pyaung-sa-bin. (Striga lutea.)	Ditto	Ditto.
128	Report on investigations made as to the causes of taints in packed teas, 1908.	C. M. Hutchinson, B.A.	Indian Tea Association.
129	Heeleaka Experimental Station	G. D. Hope, B.SC., PH.D.	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	Agricultural Chemistry.		
130	Water requirements of Crops in India, Memoirs of the Imperial Department of Agriculture; Volume I, No. 8. Price Rs. 3.	J. W. Leather, PH.D., F.I.C., F.C.S., Imperial Agricultural Chemist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
131	The Nature of the Colour of Black Cotton Soil. Memoirs of the Imperial Department of Agriculture, Chemical Series, Volume I, No. 9. Price Re. 1.	H. E. Annett, B. SC. (London), F.C.S., M.S.E.A.C.	Ditto.
132	The Salt Lands of the Nira Valley Bulletin No. 39 of the Department of Agriculture, Bombay.	H. H. Mann, D. SC., and V. A. Tamhane, L. Ag.	Government Press, Bombay.
133	Ninth Annual Report of Agricultural Chemist of the Department of Agriculture, Mysore State for 1907-08.	A. Lehman, M.A., PH.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
134	The Composition of Indian Rice. The Agricultural Ledger No. 5 of 1908-09. Price 4 annas or 4*d*.	David *Hooper*, F.C.S.	Government Printing, India, Calcutta.
	Mycology.		
135	The Wilt Disease of Pigeon-Pea and Parasitism of Neocosmospora Vasinfecta Smith. Memoirs of the Imperial Department of Agriculture Volume II, No. 9. Price Rs. 3.	E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
136	Report of the Outbreak of Blister-blight on Tea in the Darjeeling District in 1908-09: Bulletin No. 18 of the Agricultural Research Institute and College, Pusa. Price Re. 1.	W. MacRae, M.A., B.SC.	Government Printing, India, Calcutta.
137	The First Experiments in the Treatment of Grape-Vine Mildew in the Bombay Presideney. Bulletin No. 36 of the Department of Agriculture, Bombay.	W. W. Burns, B.SC., Economic Botanist.	Government Central Press, Bombay.
138	The Ring Disease of Potatoes. Bulletin No. 1, Mycological Series.	L. C. Coleman, M.A., PH.D., Mycologist and Entolomogist to the Government of Mysore.	Mysore Government Press, Bangalore.
139	Disease of Areca Palm I Koleroga. Price Rs. 2.	Ditto	Ditto.

List of Agricultural Publications in India, during 1909-10—contd.

No.	Title.	Author.	Where published.
	Mycology—contd.		
140	Report on Disease in Tea Seed Nurseries.	G. D. Hope, B.SC., PH.D., Scientific Officer to the Indian Tea Association.	Indian Tea Association.
141	Smut Disease of Jowar and Wheat. Leaflet No. 20 of 1909.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
142	The Red rot of Sugarcane. Leaflet No. 1 of 1910.	Ditto	Ditto.
	Economic Botany.		
143	Second Report on the Fruit Experiments at Pusa, Bulletin No. 16 of the Agricultural Research Institute, Pusa. Price 6 annas.	Albert Howard, M.A. (Cantab.), A.R.C.S., F.L.S.	Government Printing India, Calcutta.
144	The Milling and Baking Qualities of Indian Wheats No. 2, Bulletin No. 17 of the Agricultural Research Institute, Pusa. Price 6 annas.	Albert Howard, M.A. (Cantab.), A.R.C.S., F.L.S., and Gabrielle L. C. Howard, M.A., Associate and late Fellow of Newnham College, Cambridge.	Ditto.
145	Studies in Indian Tobaccos No. 1. The types of Nicotiana tabacum, L; yellow flowered tobacco: Memoirs of the Imperial Department of Agriculture in India, Botanical Series, Vol. III, No. 1. Price Rs. 4.	Ditto	Messrs, Thacker, Spink & Co., Calcutta.
146	Studies in Indian Tobaccos No. 2. The types of Nicotiana tabacum, L. Memoirs of the Imperial Department of Agriculture in India, Botanical Series, Vol. III, No. 2. Price Rs. 9.	Ditto	Ditto.
147	Studies in Indian Fibre Plants No. 1. On two varieties of Sann, Crotalaria juncea, L. Memoirs of the Imperial Department of Agriculture in India, Vol. III, No. 3. Price Re. 1.	Ditto	Ditto.
148	The Influence of the Environment on the Milling and Baking qualities of Wheat in India, No. 1. The Experiments of 1907-08 and 1908-09, Memoirs of the Imperial Department of Agriculture in India, Vol. III, No. 4. Price Rs. 1-8-0.	A. Howard, M.A., and G.L.C. Howard, M.A., and H. M. Leake, M.A., F.L.S.	Ditto.

List of Agricultural Publications in India, during 1909-10—concld.

No.	Title.	Author.	Where published.
	Economic Botany—contd.		
149	Leaflet No. 1 of 1910. Note on the Preparation and packing of Specimens of Plants and Insects.	Department of Agriculture, Eastern Bengal and Assam.	Department of Agriculture, Eastern Bengal and Assam.
150	Note on the Improvement of Plants (in English, Tamil, Telegu, Malayalam and Canarese).	Dr. C. A. Barber, M.A., D.SC., F.L.S.	Government Press, Madras.
	Entomology.		
151	Indian Insect Life. Price Rs. 20 .	H. M. Lefroy, M.A., F.E.S., F.Z.S., and F.M. Howlett, B.A.	Messrs. Thacker, Spink & Co., Calcutta.
152	The Red Cotton Bug. Cultivators' Leaflet No. 19.	Department of Agriculture, Burma.	Government Press Burma, Rangoon.
153	Notes on Indian Scale Insects (Coccidæ). Memoirs of the Imperial Department of Agriculture in India, Entomological Series, Vol. II, No. 7. Price Re. 1-8.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.	Messrs. Thacker, Spink & Co., Calcutta.
154	Life Histories of Indian Insects (Coleoptera I). Memoirs of the Imperial Department of Agriculture in India, Entomological Series, Vol. II, No. 8. Price Rs. 2.	Ditto	Ditto.
155	List of Names used in India for Common Insects, compiled in the Laboratory of the Imperial Entomologist, Pusa; Bulletin No. 19 of the Agricultural Research Institute, Pusa. Price 12 annas.	H. Maxwell—Lefroy, M.A., F.E.S., F.Z.S., and his Assistants.	Superintendent, Government Printing, India, Calcutta.
156	The Thrips Insects of Tea in Darjeeling.	C. B. Antram, F.E.S. .	Indian Tea Association.
157	Fasaler Poka, Text Book (Bengali) .	C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Indian Gardening Association, 162, Bowbazar Steet, Calcutta.
158	Instructions for rearing Eri Silk Worms. Leaflet in English, Hindi and Bengali.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.	Superintendent, Government Printing, India, Calcutta.
159	Eri Seed Exchange.	Ditto.	Ditto.
160	The Destruction of Grass-hoppers. Leaflet No. 19 of 1909.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
161	Leaflet on Hairy Caterpillars (in English and Tamil).	Dr. C. A. Barber, M.A., D.SC., F.L.S.	Government Press, Madras.

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REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1910-11.

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TABLE OF CONTENTS.

	Page
Introductory	1
Cotton	1
Wheat	4
Sugar	4
Implements	7
Staff	7
Donations	7
Part I. -Outlines of the Work of the Imperial Department of Agriculture	9
1. Office of the Inspector-General of Agriculture in India	9
2. Tours	9
3. Agricultural Research Institute, Pusa	10
(*a*) Administration	10
(*b*) Training	10
(*c*) Agriculture	11
(*d*) Botany	11
(*e*) Agricultural Chemistry	12
(*f*) Mycology	13
(*g*) Entomology	14
(*h*) Agricultural Bacteriology	14
Part II.—Progress in the Provinces	15
1. Bombay	15
2. Madras	16
3. Mysore	17
4. Central Provinces	19
5. Bengal	20
6. Eastern Bengal and Assam	21
7. United Provinces	21
8. Punjab	23
9. Burma	23
Part III.—Crops and Special Subjects	24
1. Crops	24
(*a*) Cotton	24
(*b*) Wheat	31

PAGE.

(c) Sugarcane 34
(d) Tobacco 37
(e) Groundnut 39
(f) Fibre Crops 40
(i) Jute 40
(ii) Flax 41
(iii) Agave 42
(g) Rice 42
(h) Tea, Coffee and Rubber 43
(i) Indigo 45

2. Special subjects:—

(a) Agricultural Education 45
(b) Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures . . 51
(c) Irrigation 55
(d) Alkali Lands 59
(e) Dry-farming 59
(f) Manures 60
(g) Sericulture 61
(h) Poultry 62
(i) Publications 63
(j) Expenditure 66

Appendix—List of Agricultural publications in India during 1910-11 69

MANITOBA (NO. 2 NORTHERN).

PUSA 4.

MUZAFFARNAGAR WHITE.

LOAVES FROM CANADIAN AND INDIAN WHEATS.

REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1910-11.

INTRODUCTORY.

It is gratifying to be able to state that the progress recorded in previous years has been well maintained: indeed as the work expands and the experience of the staff increases, the beneficent and productive character of the Department's undertakings becomes daily more apparent. As in last year's report, I propose to summarise in the introductory chapter a few of the more important items of the year, leaving the public to seek further and more detailed information in the body of the report and the publications of the department.

Cotton.—The continued increase in the ravages of the cotton boll-weevil in America and the causes which have of recent years rendered Egyptian cotton uncertain, together with a natural increase in demand, have brought about a threatened shortage in the world's outturn of cotton and forced into prominence the importance of India as a grower for the world's markets; consequently, sustained efforts are being made in the cotton tracts of the dependency to improve the quality as well as increase the quantity of the staple. In Madras, the improvements have taken two lines: one, the separation and selection of the best indigenous variety resulting in the spread of the improved local variety called *Karungani;* the other, the introduction of an exotic called *Cambodia.* The result of the efforts of the Agricultural Department with the first has been to convert

whole tracts of what were, till recently, inferior mixed Indian cottons, into pure *Karungani* tracts, and so large are the areas over which this improvement has been carried out that the trade has been actually influenced, as is testified by the following extracts from two of the largest cotton buyers in India. One firm writes: "There has been a marked improvement in the quality of Tinnevelly cotton during the last few years, especially in the Tuticorin Circle." Another firm says: "We have during the last few years noticed that a relatively very good cotton is received from places near Koilpatty . . . . . We have no hesitation in concluding that your experiment has been highly satisfactory in its results. . . . . This pure *Karungani* cotton to all intents and purposes is the best we can wish for." The second line of cotton improvement in Madras is the introduction of an entirely foreign variety called *Cambodia*, which ranks in quality with the best American, is therefore suited to the Liverpool market, and "the yield per acre is four to five times that of the indigenous cottons." From nothing, four or five years ago, it is now being cultivated in many thousand acres, and, according to the last report, "will soon be found in every part of the country and should effect a revolution in the local cotton industry." Its yield last year was 33,000 bales, valued at Rs. 60,00,000, and this year a very large increase is expected. Most of this outturn has been taken over at full prices by mills in Madras which are weaving with it a quality of cloth never before woven by machinery in this country. It is also satisfactory to know that one firm last year shipped 10,000 bales of *Cambodia* cotton direct to Liverpool, so that unlike some other parts of India a buying agency for long-staple cotton for Liverpool has been established in Madras.

In the Central Provinces, the improvement of cotton is going on apace where two varieties, one giving increased quantity of lint and the other a better quality, are being pushed, while a third, called *Buri* of the American type with lint about an inch in length, has also proved valuable under certain conditions. The importance and value of the work on improved cottons in this province may be gauged by the fact that according to the

most recent information there will this year be 100 cotton seed farms in Berar alone, covering an aggregate area of some 4,000 acres and capable of producing one million pounds of pure seed per annum for distribution to cultivators. These seed farms do not belong to Government, but are owned by land-holders and cultivators who have been induced by the Agricultural Department to grow pure seed of improved varieties for supply to cultivators. The work is controlled and supervised by the officers of the Department. All the seed has to be ginned separately in order to keep it pure, and so large has this work become that the owners of the seed farms, under the advice and with the assistance of the Department, are putting up separate ginning machinery worked by oil-engines.

In the Bombay Presidency, the improvement of the cotton plant is being well maintained. In Surat, 10,000 acres of improved Broach cotton were grown in 1911 which a Bombay syndicate offered to buy up at 5 per cent. in advance of the price paid for local cotton, though the real value of the improved variety was estimated at 8 per cent. more than the local. If the full value could be obtained, the cultivation would undoubtedly spread more rapidly, but as I pointed out in previous reports, the Indian markets as a whole being unaccustomed to deal in anything but short staple, fair rates are not always obtainable for long staple. This is the chief difficulty which the Agricultural Department has still to face in Sind where there are extensive areas suited to the growth of long-staple cotton. I am, however, glad to be able to say that the establishment of buying agencies for this quality is being seriously taken up by the trade in some parts of India, and, as already remarked, in Madras the local mills are buying *Cambodia* cotton at full prices and shippers for the Liverpool trade are in the market for this variety. The mills at Nagpur are likewise paying fair prices for *Buri* cotton. There are thus pleasing signs that the defects in trade conditions pointed out in previous reports are being recognised and that efforts are being made to remove them. In view, however, of the clamour which is often raised that the Indian cultivator should be made to grow more cotton, it cannot be too strongly insisted on that the problem of the

increase in the cotton area in this country is an economic one. Unlike crops like sugarcane, the area under which could be vastly increased by the application of capital, the cotton plant comes into direct competition with other common Indian crops grown with very little, if any, capital at all, and although of recent years a very large increase in area has taken place due to better prices, the maintenance and enlargement of that area must entirely depend upon the relative value of cotton compared with other crops.

Wheat.—Progress in the production of wheats of high quality and high yielding power and their testing and introduction in different localities continues. In the trials for yield carried out at Pusa during the past year, a wheat selected from a cross made in 1906 heads the list with a yield of over 34 maunds per acre. Selections from crosses similarly made at Pusa have been pronounced by home authorities equally valuable with the best Manitoba. The frontispiece sufficiently depicts the approximation of a loaf made from Pusa wheat to one made from best Canadian, and shows the inferior quality of one of the principal Indian export wheats. The main lines of work will now rest in testing and introducing these wheats into other districts in India, and in the development by breeding of strength of straw to enable the plant to carry heavy yields and of rust resistance. At Hoshangabad in the Central Provinces, seed farms have been established for the production of pure wheat seed on a large scale. The area of these farms will this year aggregate 5,000 acres, capable of producing enough pure seed for 30,000 acres per annum. In the United Provinces, nearly 13,000 maunds of wheat seed was distributed from the depôts in that province.

Sugar.—The importance of the sugar industry to India, and the critical position in which it is finding itself to-day, merits special mention. In consequence of the situation, more or less serious, which has arisen, the Board of Agriculture was called together in November last, some three months before due date, principally on this account, in order to advise Government on the policy it should adopt in regard to sugar. Although the

meeting was held at a time not strictly coming within the period of this Annual Report, it is, I think, permissible, owing to the importance of the subject, to refer to it here. As I pointed out in my opening address to the Board, "there are certain ominous signs in the condition of India's sugar trade which we cannot afford to ignore. With increased facilities for cheap ocean traffic to and from all parts of the world, and with the easy means of transit within herself brought about by her net-work of railways, India has been deprived of the natural barriers which formerly protected her primitive industries, and consequently her sugar markets have been invaded by cheap white sugar from abroad. The imports of this white sugar have risen in the past twenty years from 80,000 tons to 700,000 tons per annum. It is not only displacing the existing indigenous white sugar, but owing to its cheapness the consumption of extra quantities of white sugar is encouraged, especially where the influence of Western civilisation is being most felt, and it is being mixed with molasses and *gur* and retailed as *gur*. It is thus undermining the foundations of the *gur* industry as well as of the indigenous refined product. The effect has been to cause a decline in the area under cane and a decrease in the number of sugar mills and refineries in the more important sugar tracts of India." As the result of the evidence placed before the Board and the discussion which took place, the following points were agreed to in a series of resolutions:—(1) That owing to its threatened position the sugar industry deserved the assistance of Government; (2) that the appointment of a Sugar Engineer was necessary; (3) that sugar stations should be located in sugar tracts; (4) that an acclimatisation and cane-breeding station should be established for the production of high quality canes; (5) that facilities should be afforded to capitalists for the acquisition of land and the erection of central factories and assistance should be given by subsidy or otherwise to pioneer factories.

The appointment of a Sugar Engineer has already been carried out and he has been placed under the Director of Agriculture in the United Provinces, where half the sugar of India is produced and the industry is vital to the welfare of the

agricultural population. The establishment of a cane-breeding station is under the consideration of the Government of India, and the location of sugar stations in sugar tracts will doubtless receive the attention of Local Governments. It is too soon to report on the facilities it will be possible to afford to capitalists for central and pioneer factories, but the matter is being enquired into and there seems little reason to doubt but that there exists great scope for the successful introduction of the centralised sugar factory system. It is perhaps not generally known that there are factories in both North and South India, working in recent years upon this system, that have demonstrated the possibility of making white sugar direct from the cane, at a profit to both the sugar factory and the grower, with sugar selling at the minimum market price. And further, as indicated by the evidence placed before the Board, there are large areas of waste land available to capitalists capable of producing large crops of cane and waiting the erection of factories on the centralised system. Thus, if the salvation of the Indian sugar industry lies in the adoption of this system, as there appear very good grounds for believing, there would not only seem no reason to doubt but that the whole of the foreign sugar now imported into India could be made in this country, but there would even seem to be room for imagining the possibility of an export trade to foreign countries. These considerations appear to be warranted by the evidence submitted to the Board. It only remains for those interested to avail themselves of the information thus afforded. The Agricultural Departments throughout India have undertaken to do all they can to assist in the introduction of better canes and better methods of cultivation, and if the establishment of a cane-breeding station, as recommended by the Board, is carried out, the production of cane will have been placed on a higher plane, and with the spread of the central factory system there is ground for predicting the possibility of India soon being abreast of other countries in its methods of sugar production. In anticipation of the assistance that will be required, the Assistant Inspector-General of Agriculture in India, has been entrusted with the task of starting experiments on sugar plantations for the introduction

of high quality canes and improved methods of cultivation, and his services are available for the purpose.

Implements.—During the past two seasons reapers specially adapted to suit Indian conditions have been introduced into the Punjab, amounting to nearly 200 and capable of dealing with some 12,000 to 15,000 acres. I doubt whether these implements were taken up with so much avidity and rapidity in England, when they were first introduced into that country, as they are by the Punjab cultivator to-day. This improvement has gone beyond the stage of an experiment, and reapers with their parts are now stocked and supplied direct to cultivators by Messrs. Volkart Brothers, from their godowns at Lyallpur in the Punjab. But there is not only the benefit to the cultivator this improvement brings, I believe I am safe in saying that the great irrigation projects now in contemplation in the Punjab will not be entirely fruitful without the aid of labour-saving appliances like the reapers, ploughs, threshers, and winnowers which are being introduced among the Punjab cultivators.

Staff.—On the question of staff I have to repeat what I stated last year, that it is quite inadequate to cope with growing needs, and there are instances where the public are clamouring for the extension of the work of the Department, a demand which has to remain unsatisfied. The retrenchments rendered necessary on account of the present financial difficulties are causing a set-back in progress and much that could be done has to be left undone. It is unfortunate that this state of affairs should have overtaken the Department during its infancy and before the complete staff at one time contemplated had been appointed.

Donations.—In commemoration of the visit of Their Imperial Majesties to India, the Hon'ble Sir Sassoon J. David has placed at the disposal of the Government of Bombay the munificent donation of Rs. 8,00,000 for the establishment of vernacular agricultural schools and the improvement of agricultural methods in that Presidency. Seeing how agriculture is the foundation of the welfare of the people, especially in this country where three in every four of its inhabitants depend

directly on the products of the soil, no more useful benefaction could have been made. With Mr. Phipps' gift of £30,000 to the Pusa Institute, it forms the second endowment of any importance in aid of Indian agriculture. In these days of progress and reform, when schemes are in the air for free and compulsory education, the raising of vast Universities and the creation of Technical Institutes, I may be forgiven if I take this opportunity of pointing out to those of the public who are truly desirous of aiding in the amelioration of their country, that they can do so in no more effective manner than by emulating the examples of Mr. Phipps and Sir Sassoon J. David. Government has spent, and is spending, a great deal in the creation, organisation, and maintenance of the Agricultural Department; but funds fall short of what is needed, and it cannot be expected that in undertaking the improvement of the agriculture of such a vast empire, Government can supply all that is wanted. India is far behind other countries, principally on account of its primitive methods—as witness the condition of its sugar industry. Yet, judging from the results already achieved by the Agricultural Department in the short six years of its existence, I feel justified in the belief that there is no more promising field for public benefactors desirous of improving the condition of the people, fostering industry and commerce, and bringing India into line with other countries than the aiding with their donations the development of that industry which is the foundation of the country's wealth and prosperity.

I have to thank Mr. A. C. Dobbs, Assistant Inspector-General of Agriculture in India, for having undertaken the compilation of this report.

BERNARD COVENTRY,
Officiating Inspector-General of Agriculture in India.

PUSA;
The 27th January 1912.

PART I.

Outlines of the Work of the Imperial Department of Agriculture.

1. *Office of the Inspector General of Agriculture in India.*—The post of the Inspector General of Agriculture in India was held by Mr. Bernard Coventry throughout the period under report. The post of Assistant Inspector General was held by Mr. A. McKerral, M.A., B.Sc., till the 28th February 1911, when he went on privilege leave for three months. On his return from leave, he reverted to his permanent post of Deputy Director of Agriculture in Burma, and Mr. A. C. Dobbs, B.A., Principal of the Agricultural College, Sabour, was appointed in his place. He took over charge of his duties on the 17th June 1911. He also holds charge of the Pusa Farm and the cattle and poultry breeding work.

2. *Tours.*—The Inspector General's time was, as usual, largely spent on tour. He visited the principal agricultural stations and farms under the Departments of Agriculture in Bombay, Bengal, the United Provinces and the Punjab, inspecting the work in progress, and made a short tour in Eastern Bengal and Assam in connection with the jute industry. At the request of the Baroda State, he also visited and advised regarding the experimental farm at Baroda. In Behar, the experiment station at Dooriah belonging to the Behar Planters' Association, and the Indigo Research Station at Sirseah, and in the United Provinces, Colonel Ward's Poultry Farm at Huldwani (all of which are subsidised by Government) were also inspected. In Cawnpore he visited the Agave plantation belonging to Messrs. Allen Bros. Besides these tours of inspection, the Inspector General visited Simla twice to confer with the Government of India, attended the meeting of the Board of Scientific Advice in Calcutta, and took part in the United Provinces Agricultural Conference convened by Mr. Moreland at the Allahabad

Exhibition. He also attended a meeting of the Bengal Silk Committee.

3.—*Agricultural Research Institute, Pusa*—

(*a*) **Administration.**—The work of the Pusa Research Institute continues to expand. There are now seven sections, dealing respectively with agriculture, chemistry, botany, mycology, entomology (subdivided into two sections) and Bacteriology. Dr. Butler, the head of the Mycological section, officiated as Director of the Institute during the year. Mr. Maxwell-Lefroy, Imperial Entomologist, during his absence on long leave, gave a short course of lectures on Entomology at the Royal College of Science, London. Mr. Fletcher, Supernumerary Entomologist, was in charge of the section during his absence. Mr. Howard has taken up his work in connection with the extension of the Baluchistan fruit industry; he was also deputed to advise the Kashmir Durbar on hop cultivation, and during his leave in England in 1910, spent some time on deputation in obtaining recent information concerning these industries, and in connection with his work on wheat. Mrs. Howard, who has since 1906 uninterruptedly assisted her husband in his work, has been appointed his Personal Assistant. Towards the end of the year under review three Supernumerary officers were absent from Pusa on deputation or filling leave vacancies, and the Assistant Agriculturist's post was vacant owing to Mr. Sherrard's appointment as Professor of Agriculture at the Sabour College, Bengal. Details of the changes in the staff of the various sections are given in the Report of the Institute.

(*b*) **Training.**—The number of post-graduate students continues small. There were at the end of the year only six at the College, two in Chemistry, three in Entomology and one in General Agriculture. Now that the Provincial Colleges are in working order, it is not expected that there will be much further demand for the latter course. The Provincial Colleges are not, however, yet in a position to give practical instruction in the subjects of the short courses at Pusa, *viz.*, fruit-growing, Eri-silk, lac culture and cattle and poultry management. Forty-six students in all attended these courses during the year. The short course, in tillage and implements, has been discontinued.

(*c*) **Agriculture.**—The farm has been in charge of three different officers in the year under report and the continuity of the work has thus suffered considerably since the reduction of the appointment of Agriculturist. However, the greater part of the laying out and reclamation has been done, and considerable improvement has been effected in the cultivation, and, with the larger variety of crops that it is possible to grow now that the needs of the cattle as regards fodder can be more than met, there will be greater scope for experimental work. Chief among the factors contributing to the increased ease of fodder supply has been the making of silage on a large scale. The greater part has hitherto been made in masonry silos, but during the last year silage has been made with complete success in a simple pit in the ground, and it seems probable that this is the cheapest and best method even with the moist soil of Pusa. A certain amount of experience is required as to the best times for siloing different crops, the amount of pressure to apply, and so on, and these points are receiving attention.

With the improvement of the herd of Montgomery cattle the foundation is being laid upon which a dairy can be established, should it become possible to extend the work of the Institute to research in this important branch of agricultural industry, and to meet the demand that already exists for practical instruction in dairying.

The work on poultry has shown that the best all-round utility breeds thrive well at Pusa, and work will be continued with these only among imported fowls and with two indigenous pure types of game breeds.

(*d*) **Botany.**—Mr. Howard's work on wheat and tobacco is dealt with in the sections devoted to those crops below (pages 31 and 37). While in England he studied the trade requirenection with hop-growing in Kashmir and the latter with the methods of hop-growing and fruit-packing, the former in connection width hop-growing in Kashmir and the latter with the Baluchistan fruit industry. The possibilities of hop-growing in Kashmir are apparent from the fact that with a production per acre of less than a fifth of that of Kent an average profit of

over £7 per acre has been realised on the Government hop garden for the last 16 years. In his report to the Durbar, Mr. Howard indicated the improvements that are possible if the work is to be continued on present lines, and the steps that would be necessary if, by placing its industry on a modern basis, Kashmir is to enter the hop markets of the world as a competitor with California. As regards Baluchistan, lines of work for the development of the fruit industry were worked out in detail and the site of a new experimental station was selected.

Work on pollination in important Indian crops was continued at Pusa and a Memoir on the subject published. Natural cross-fertilisation was found to occur in *Til* (*Sesamum indicum*), *Rahar* (*Cajanus indicus*), *Niger* (*Guizotia abyssynica*) and in Jute (*Corchorus capsularis*). Some progress has been made in working out the details of pollination in Indian oil-seeds. A Memoir has been written by Mr. and Mrs. Howard on " Studies in Indian Fibre Plants " in which it is shown that the undesirable effects of natural cross-fertilisation in *Hibiscus cannabinus*, which it is important to keep pure in order to get uniformity of fibre, can be almost entirely prevented by weeding out undesirable plants in the seedling, or early vegetative stage when they present easily recognisable differences, and it is suggested that this method may be extended to other crops such as cotton which there is difficulty in maintaining true to type.

(*e*) **Agricultural Chemistry.**—Work on *Usar* land has been continued in consultation with the Director of Agriculture and the Irrigation Department in the United Provinces with special reference to the question whether irrigation increases alkali in certain lands.

Special attention was drawn in last year's report to Dr. Leather's work on the water requirements of crops in India. This work has been continued, and another Memoir on the subject (No. 10 of the Chemical Series), has been published. The most interesting conclusion arrived at by Dr. Leather is that practically the whole of the water assimilated by a crop is obtained within the root-range—some 6 to 7 feet in alluvial soil—

and that the great stores of water below this depth are substantially of no service to the plant. Most interesting results have also been obtained from drain-gauges at Cawnpore and Pusa as to the rate of evaporation of water from fallow and from cropped land respectively, and as to the formation and movement of nitrates in the soil.

An improved method of refining crude salt-petre was devised by Dr. Leather, and has been described in a Bulletin (No. 24). More nitrate is obtained than by the ordinary methods in use, the product is of higher quality, less fuel is required, and the process is independent of the weather. Its financial possibilities, however, remain to be demonstrated and arrangements have been made to test the method on a commercial scale.

(*f*) **Mycology.**—In order to facilitate progress in this branch of agricultural science, which is greatly hampered by the difficulty of determining the identity of Indian fungi, much time has been given to systematic work in this section. All the specimens of one of the larger groups have been worked through, and annotated lists prepared for publication.

A full account by Dr. Butler of the palm disease in the Godavery and Kistna deltas and of the campaign against it has been published as a Memoir. The operations undertaken at Dr. Butler's instigation have been entirely successful, and the disease has been limited in Godavery to the area previously infested. The work in Kistna was started later, but a distinct decrease in the mortality is noticeable.

The Indian Tea Association have decided to engage a mycologist, but, meanwhile, assistance has been given by Pusa in the investigation of tea "blights." The blister blight is spreading to a dangerous extent in Darjeeling, and Mr. McRae, then Supernumerary Mycologist at Pusa, published a Bulletin at the beginning of the year indicating the lines on which its control should be attempted. Another disease was shown, by Dr. Butler, probably to be due to an insect which punctures the seed, thus admitting rotting fungi to the tissues inside. It is believed that this insect can be fairly easily destroyed.

Diseases both of agricultural crops and of forest trees have also been investigated, and advice as to their control has been given to the public.

(*g*) **Entomology.**—There are now seventeen Entomological assistants in the Provincial Departments and much of the work of this section at Pusa consists in identifying pests reported by these and advising as to the methods of control. Successful demonstrations of such methods have been made on a large scale in the provinces.

Great interest is taken by the public in sericulture. Experimental work has been continued at Pusa both with eri and mulberry silk-worms and the section has supplied not only advice but disease-free eggs, castor seed and machines for spinning, etc., to a large number of correspondents. Lac investigations have been continued. Studies of the life-histories of Indian insects continue and two Memoirs have been published.

In connection with the Railway Sleeper Commission Mr. Fletcher is carrying out experiments on the preservation of sleepers from the attacks of termites.

The work of the Second Entomological section relates to dipterous insects, of which the more important, owing to the part they play in the transmission of disease, are those that suck blood; and the work is likely to develop chiefly in this connection. Mr. Howlett who is in charge of this section returned in March from 17 months' sick leave during which he attended, as Indian delegate, the first International Congress of Entomology at Brussels. While on leave, he also collaborated in a series of experiments on the range and rate of flight of houseflies, the results of which were published by the local Government Board in England. After his return to India he took up investigations into methods of control of "Horse-flies" (*tabanidæ*) mosquitoes, and fruit flies; which promise useful results.

(*h*) **Bacteriology.**—The important part played by bacteria in soil fertility is now well recognised, and Mr. Hutchinson has studied at Pusa the methods best adapted to bacteriological work under Indian conditions, with a view to determining the

optimum conditions for the activity of those organisms which favour the conversion of organic matter in the soil into nitrates assimilable by plants. The possibility of a bacteriological explanation of the increase in fertility due to hot weather cultivation, has been the subject of special study which gives promise of interesting and valuable results.

Bacterial diseases of tobacco, and of eri-silk worms, have been investigated. Ratin and Trope Ratin, recommended for the extermination of rats, have been studied and found of little practical use in India, the former having lost its virulence, and the latter being too expensive a remedy. In view of the growing importance of bacteriology, in agriculture and the industries dependent on agriculture, proposals are being made for strengthening the section, which is understaffed.

PART II.

Progress in the Provinces.

1. *Bombay.*—Half the superior staff of the Bombay Department of Agriculture are stationed at Poona, which the Agricultural College, its library, laboratories and farm, the Poona Dairy, the Ganeshkhind Botanical Gardens and the Manjri Farm combine to make an effective head-quarters. The extensive outside work of the Department in many parts of the Presidency takes up, however, much of the time of this central staff, and Mr. Keatinge, the Director of Agriculture, agrees with the Committee which recently reported on the College that the staff is insufficient for the work undertaken. It has not yet been possible to obtain the additional staff required. In the districts the work has expanded : a farm has been opened at Alibag, and the Gokak and Sukkur farms have been considerably developed. Financial stringency has prevented the opening of the proposed farm at Larkana for the present. There are now, serving in the Department, 50 men who are graduates of the Agricultural College or are graded with them. Mr. Keatinge is disappointed with these men, most of whom he says are content with a mere routine performance of their work and show little desire

to make and record any independent observations, or to develop any original line. This he attributes to the want of sufficient personal training consequent on the extensive duties of the Deputy Director under whom they are working, who has to supervise eight scattered farms;—an impossible charge for one man, and one the sub-division of which has been recommended to Government.

The important development of the work of this Department in connection with agricultural education under Dr. Mann's energetic guidance is referred to in the section devoted to Education later on in this Report. The work done in well-boring in Gujerat deserves special notice in view of the apparently increasing frequency of serious droughts in that division. The deep plough, worked by a bullock gear, imported from France for breaking up the black soil in the Deccan and Southern Maratha Country, is a new development in the application of bullock power to land in India. An account of its work was given by Mr. Keatinge in the Agricultural Journal of India for October 1911. Arrangements have been made to hire it out for ₹100 per month, and the future of this venture will be watched with interest.

2. *Madras.*—The Madras Department is now perhaps the best staffed of the Provincial Departments; a Mycologist was appointed last year and application has been made for the appointment of an Entomologist. There are also two Deputy-Directors independent of the College at Coimbatore. Moreover, much of the work of agricultural engineering which in other provinces devolves on the Agricultural Department has hitherto been in the hands of the Department of Industries in Madras. The College has been more successful than any other in India in obtaining a large proportion of students of the desired class; about half being the sons of land-owners whose object is to acquire a knowledge of practical farming which will enable them to manage their own properties to better advantage. The advantages of a relatively strong staff are already being felt in the economic effect of the improvements introduced or spread by the Department. The substitution of *Karungani* for inferior cottons in Tinnevelly has

caused an improvement in the cotton from that district which has been remarked on by exporting firms, and the substitution of Red Mauritius sugarcane for local varieties in Godavery and South Arcot has been accompanied by a large increase in the area of cane grown in those districts. The introduction of Cambodia cotton as an irrigated garden crop, though not primarily due to the Department, has been greatly facilitated and accelerated by its efforts. The figures given in the Department's Annual Report show also that the methods of cultivation and manuring introduced by the Department are producing an effect, and we may look to a considerable and fairly rapid increase in the prosperity of Madras agriculture as the result of the combined introduction of better varieties of crops and higher cultivation. The *Agricultural Calendar* published by the Department promises to be a useful means of promulgating its recommendations. Agricultural exhibitions and shows have, on the other hand, been found of very little value, and the withdrawal of official support from them and from the agricultural associations, which appear never to have done any real work, is under consideration.

3. *Mysore.*—Dr. L. C. Coleman was in charge of the Agricultural Department during the year. It would appear that the staff is quite inadequate to cope with the constantly expanding work and great difficulty has been felt in meeting the increasing demands for demonstration work throughout the State. The Inspector General of Agriculture was consulted by the Durbar on various points connected with the working of the department and advised an increase in the expert staff as warranted by the importance of the work that was being done. The following papers were published during the year:—

(1) Diseases of the Areca Palm I. Koleroga, Mycological Series—Bulletin No. 2.

(2) The Rice Grasshopper (*Hieroglyphus banian, Fabr.*) Entomological Series—Bulletin No. 1.

(3) The Jola or Deccan Grasshopper (*Colemania sphenarioides, Bol.*) Entomological Series—Bulletin No. 2.

These publications disclose work of great value and of a high order of merit. There were published besides, circulars giving information of practical interest on specific subjects.

The experiments in the cultivation of *Ragi* have been continued and special attention has been paid to the uses of green manuring. There have been marked results obtained where the green crop was manured with small quantities of phosphoric acid and potash. Experiments in early ploughing have shown very marked results, the early ploughed plots giving about 70 per cent. greater yield than the later ploughed ones.

In the experiments on rice, green manuring has been found beneficial, and where two crops a year are grown the green manure seed is sown broadcast in the paddy some two or three weeks before the harvest. Contrary to expectations, the results obtained by ploughing immediately after harvest have been inferior to those obtained by leaving the land unploughed until immediately before transplanting. Nitrate of potash has not been found to be economical as a nitrogenous manure for paddy.

Good results, amounting to 20 and 30 per cent. increase, have been obtained by the selection of paddy seed with the salt water method practised in Japan. It consists in the immersion of the seed in a salt solution of density sufficient to float an egg with an eight-anna piece attached. When seed is immersed in this solution a considerable quantity floats which is discarded leaving the heavier and better seed to be used for sowing. The sugarcane experiments mentioned in previous reports have been continued.

Demonstration work forms a large and important feature of the work of the Mysore Agricultural Department, and includes lectures and demonstrations of improved agricultural methods at fairs throughout the State, organised campaigns against plant diseases and pests, demonstration of improved methods, and instruction work in the use of improved implements extending over some considerable time.

Investigations in the Chemical Laboratory included the examination of samples of green manures, determinations of soil moisture under varying systems of cultivation, the

examination of sugarcanes, and a large amount of miscellaneous work.

The chief work under the head of Mycological investigation and demonstration has been that in connection with the disease of *supari*. An examination of the records from other gardens shows that the methods adopted by Dr. Coleman are better than the local methods, by about one-fourth of the crop. A Canarese edition of the bulletin on the disease has been prepared and extensively distributed amongst the people. Other diseases which are engaging the attention of Dr. Coleman are the ring disease of the potato, the smut in Jola, a second disease of *supari* and the spike disease of Sandal.

Much attention has been given to the entomological branch of agricultural work during the past year. The Jola grasshopper has become a very serious pest, a description of which has appeared in Entomological Series Bulletin No. 2. A Canarese account has also been prepared for distribution to cultivators. A campaign has been organised and is being carried out against the pest, the results of which must be awaited. The rice grasshopper is also a very serious pest against which combative measures have been undertaken.

4. *Central Provinces.*—In this Province also there are two Deputy Directors independent of the College at Nagpur, and the progress to be recorded is very considerable. It can best be realised from the figures given in the department's Annual Reports, showing the amounts of seed distributed and the extension of the system of transplanting rice advocated and demonstrated by the department. But the accounts of the Akola farm published in the separate Report on the Agricultural Stations, and showing a balance of about Rs. 2,000 profit, after paying the cost of the demonstration staff employed in the Berar Division, furnish independent evidence of the efficiency of the organisation under Mr. Clouston; while it is clear from the rapid multiplication of private seed farms devoted to the growth of wheat in the Northern Circle that Mr. Evans' work will very soon have an important effect on the market in that cereal. The work done by this department in assisting the

Irrigation Department to educate the cultivators of the Central Provinces in the use of irrigation water, is referred to in the section on irrigation below in this report. The agriculturists of the Central Provinces do not appear to take kindly to higher education, and the College will probably have to wait for the extension of the Department's work in other directions before the demonstrated effect of improved methods brings home to the land-owning classes the advantages such an education offers.

5. *Bengal.*—The energies of three out of the four European experts of the Bengal Department of Agriculture have been concentrated on the College at Sabour, while those of the Deputy Director who is independent of the College have hitherto been distributed over farms in six out of the seven divisions of the province. Under these circumstances it is not remarkable that while the reports show that a great deal of work has been done by the several officers, no very great progress in the improvement of the agriculture of the province has been made. Considerable success has been met with in demonstrating the method of preserving potatoes from the potato moth by storing in sand. A feature of the Department's work has been the successful organisation of agricultural exhibitions by Mr. Woodhouse, now Principal of the College at Sabour, who has published the results of his experience in this work in the "Departmental Records" issued by the Department. Mr. Taylor's work on the ripening of sugarcane, the results of which were published in another "Record," deserves special mention as illustrating a line of work that is likely to be useful in connection with the reorganisation of the Indian Sugar Industry. Much detailed work on leguminous crops has also been done at Sabour, where soybeans, of which several varieties are indigenous in India, are receiving special attention.

Interesting work is in progress in connection with fisheries in Bengal. The appointment of a Deputy Director for two years and two permanent posts of Superintendents of Fisheries have been sanctioned.

The work in progress under the Bengal Silk Committee, of which the Director of Agriculture is President, is referred to

in the paragraph under *Sericulture* later on in this report. It indicates a new departure in the shape of a trial which is to be given to a system of hybridising European and Indian silk-worms with the object of producing a race yielding silk of better quality.

6. *Eastern Bengal and Assam.*—The foundation of experimental work on which improvement in agricultural practice in Eastern Bengal and Assam must be based is in process of being established. The work of laying out the Dacca farm has been continued during the past year; several experiments have been started and the laboratory was opened in May 1910.

Perhaps the chief results of experiments so far have been to demonstrate the value of striped Mauritius sugarcane over any of the local varieties; of green manuring; and of bone-meal for paddy. Messrs. Birt and Meggitt contributed to the discussion of the question of manures at the seventh meeting of the Board of Agriculture a valuable note based on their experiments with these manures. The tobacco experiments at Burirhat are very promising, and the sericultural station at Mirganj is in a fair way to pay its expenses.

The operations of Colonel and Mrs. Cole for the improvement of poultry in the Lushai Hills noted below under the head of "Poultry" are probably the first of their kind to have been so successful in India.

The form and arrangement of the Annual Report of this Department are particularly good, and are of the greatest assistance in facilitating reference to the several items of the Department's work. In these days of the making of many books, too much stress can hardly be laid on the value in reports, of this quality, without which much excellent work is lost to the world owing to the impossibility of segregating, in a limited time, the information given on the several subjects dealt with.

7. *United Provinces.*—The equipment of the Agricultural Station at Cawnpore has been almost completed with the opening of the College and laboratories for use during the year. It has been decided to build a science library for the joint use of

the Department of Agriculture and the newly created Department of Industries. The central institution having thus been completed it is proposed to increase the number of agricultural stations in outside districts. A seed farm at Aligarh and a station in the sugar yielding tract of Rohilkhand are in contemplation, and it is suggested by Mr. Moreland that there should be a local centre in every district for the dissemination of the advice and recommendations of the Department.

During the past year three of the officers of the Department have been on privilege leave and Mr. Burt's time was largely taken up in connection with the Allahabad Exhibition. The Agricultural Court, of which Mr. Burt was the organiser, was an unqualified success; accounts of the Sugar Factory, and of the sections devoted to implements, waterlifts, and produce respectively, have been given in the July number of the Agricultural Journal of India for 1911. At the Exhibition, an Agricultural Conference was held which was attended by a large number of landholders and others interested in agriculture, who thus had an opportunity of meeting one another and exchanging their views on agricultural development.

Mr. Leake's work which has paved the way for the evolution of new and improved cottons in India is referred to in the section devoted to that crop below. Useful work has been done by Mr. Clarke at Partabgarh on sugarcane, and the results have been published in a bulletin of the Pusa Institute. The well boring work of the Department has continued during the year. The post of Agricultural Engineer became vacant, in March, on the appointment of the officer in charge to the Roorkee Workshops, and the Chief Engineer was unable to select another officer for the appointment.

Thirty-four students obtained the Degree of L. Ag. at the Cawnpore College in 1911. Only one landholders' association responded to an offer of preferential admission, for nominees of such associations, to the College; one student being nominated by the Muzaffernagar association. The control of the weaving schools hitherto managed by the Agricultural Department, has been taken over by the Department of Industries.

8. *Punjab.*—It is regrettable that there seems to be no immediate prospect of the Lyallpur Agricultural College becoming popular among the land-holding classes. Three out of the four European officers of the Agricultural Department in the province are attached to the College and have comparatively little time for other work. The chief developments to be recorded are therefore in the work under Mr. Milligan, the Deputy Director, whose headquarters have recently been established at Gurdaspur. His success in introducing iron ploughs of a useful type, as well as reapers, winnowers, and other machinery, and in putting the supply of these implements and machines on a business footing, in the hands of Messrs. Volkart Bros., is referred to under the head of implements in the third part of this report. Satisfactory progress has also been made with well boring, which has recently been taken up.

The cultivation of Dharwar American cotton, introduced some years ago by the Department, continues on a fairly large scale particularly in the Jhang Division of the Chenab Colony where it is cultivated principally by the *Janglis* of precanal days who have been settled on irrigated land and are learning the arts of intensive agriculture.

A recent development, due to the Agricultural Department, is the remission of water rates on sann hemp ploughed in for green manure. This crop, sown at the beginning of the rains in July (if there are any rains worth mentioning) requires little irrigation for the short time during which it occupies the ground, and the concession referred to is likely to lead to a considerable extension of this effective system of manuring.

A determined effort is being made to introduce first class dates into this province. Suckers imported from the Persian Gulf are being grown at Multan, Muzaffergarh and Lyallpur, and an Arab has been brought from Basra to look after them.

9. *Burma.*—Mr. McKerral gave up the appointment of Assistant Inspector General of Agriculture in India, and returned to Burma in May 1911, to take charge of the Southern of the two circles into which the Province has recently been divided. Mr. Holmes-Smith, originally recruited for the post of Economic

Botanist, left the Department before taking up that appointment. There are thus only three European experts on the staff, two Deputy Directors and the Agricultural Chemist. An Agricultural Station has been taken up at Hmawbi for Lower Burma, but, in the absence of buildings and equipment, nothing but preliminary work is possible. No demonstration work has hitherto been undertaken owing to lack of staff.

The Mandalay Agricultural Station was established in 1907. A large number of experiments with manures, varieties of crops, and implements, are in progress there, under Mr. Thompstone, Deputy Director of the Northern Circle.

The work of the Agricultural Chemist is chiefly connected with the analytical survey of soils and silts and also of sugarcane.

The appointment of the Director of Agriculture as joint Registrar of Co-operative Societies has established close relations between the two Departments, and a scheme has been prepared for the creation of a staff of district vernacular agriculturists to serve as intermediaries between the Agricultural Department and these societies and the public.

PART III.

Crops and Special Subjects.

1.—*Crops.*

(*a*) *Cotton.*—The steady spread of the cotton boll weevil in America and the increase in the demand for this staple are adding to the importance of India as a grower of cotton for the world's markets.

A note by the Inspector General of Agriculture on the position of cotton investigation in India was published during the year, as a Bulletin, in which it was shown that there has been no lack of attention to the problems both of increasing the quantity and improving the quality of the staple on the part of the Agricultural Department, but that before the production of long stapled cotton would pay cultivators, agencies for

buying such cotton at its full market value would have to be set up. It is gratifying to be able to record that owing to the increase of cultivation of *Cambodia* cotton referred to below,—an increase which has been very much accelerated by the efforts of the Madras Agricultural Department—this difficulty in the disposal of long-stapled cotton has been solved in that province. There is a keen demand for this cotton, both locally, and in England where it is known as "Tinnevelly American," and the Madras mills are now making from it a much finer quality of cloth than was possible before. There is little doubt but that a market for cotton of this quality having once been established in the country, the progress of the cultivation of long-stapled cottons in districts suitable to them will be rapid.

Scientific Work.—While economic results are the ultimate object of the work that is being done, they cannot be permanently maintained or increased unless a solid foundation is laid; of knowledge of the plant, its characteristics, and the conditions under which it thrives and gives the best return. From this point of view, the work done in the United Provinces on typical Indian cottons is of the greatest importance. Mr. Leake published, in 1908, a note in the Journal of the Asiatic Society on the occurrence of natural cross-fertilisation in cottons in Northern India. In a Memoir (1911, Botanical Series, Vol. IV, No. 3), he has now shown, not only that cross-fertilisation between the flowers of neighbouring cotton plants takes place to a considerable extent under field conditions in India, but that a considerable degree of sterility results from self-fertilisation repeated through a number of successive generations. The practical bearing of these considerations is of great importance and is well explained in a note written at the request of the management of the Agricultural Court, United Provinces Exhibition, by Mr. Leake and Dr. Parr, and published in the Agricultural Journal of India for January 1911 (Vol. VI, Part 1), in which a scheme for the introduction of improved types of cotton in the United Provinces is outlined.

It is necessary, however, to read the Memoir referred to to realise the influence that this factor of natural cross-fertilisa-

tion may have had in the past in causing the degeneration of exotic cottons introduced into India and in preventing the emergence of well defined types of indigenous cottons in the absence of rigid selection of seed. It is not too much to say that the definite establishing of the facts referred to has removed one of the chief obstacles in the way of the improvement of cotton in India.

Hybridisation, Selection and Distribution of Seed.—In view of the extent to which hybridisation has thus been shown to take place under natural conditions, the actual work of hybridisation becomes comparatively unimportant compared to that of the selection that is necessary, whether the plants dealt with are deliberately produced hybrids or individuals selected, for special qualities, from field crops. The object in all cases is to secure a combination of desirable qualities, to establish a strain of plants, having these qualities, that breeds true to type, and to maintain it free from contamination. From the point of view of quality of lint, there are three main divisions into which cottons can be grouped for purposes of improvement. These are :—

(1) Short-stapled Indian cottons.
(2) Long-stapled Indian cottons.
(3) Exotic cottons.

With regard to the first of these, efforts are directed towards obtaining the greatest possible weight of ginned cotton per acre by means of increasing the gross yield of seed cotton and the percentage of lint to seed. As regards the second group the length of staple has also to be considered and as regards the third the difficulty hitherto has been chiefly one of acclimatisation.

In Bombay, short-stapled cotton has proved itself most suitable for Khandesh, and at Dhulia there has been produced, and is being maintained by selection, a strain of the variety *roseum* that gave, in 1910, over 900 lbs. of seed cotton per acre, with a ginning percentage of 37·5, which sells at Rs. 21-8 per maund (of 144 lbs.) as compared with Rs. 20-8 for the local seed cotton. The price of the lint—Rs. 310 per candy as against Rs. 350 for

fine Broach,—is of course low but this is more than compensated for by the superiority of yield in this district.

As regards longstapled Indian cottons, at Surat, where *Broach* cotton is grown, the number of varieties for distribution has been narrowed down by selection to two, which give a distinct advantage both in quantity and quality over the ordinary local cotton, a fact which is appreciated both by the cultivators and the trade. Ten thousand acres were sown with this seed in 1911, and a Bombay syndicate undertook to buy up 2,000 bales of the produce at a figure 5 per cent. in advance of the current local rates. The real value of this cotton is, however, estimated as at least 8 per cent. more than that of the local variety, and if fair rates could be obtained the cultivation would spread more rapidly.

In Madras, at Koilpatty, of the two Tinnevelly varieties, that known as *Karungani* has a longer staple and has also given a heavier yield than the *Uppam* variety; a selected strain of the former has given an improvement of over 1½ per cent. in the proportion of lint to seed as compared with the ordinary crops, and the lint of some selected pedigree strains has been valued as high as Rs. 380 per candy of 784 lbs. as compared with Rs. 345 for the ordinary field crop and Rs. 335 for ordinary *Uppam*. In Tinnevelly, nearly 120,000 lbs. of *Karungani* seed, sufficient to sow over 14,000 acres, were sold, at 43 depôts; the cultivators realise that they get better crops from this variety and keep seed from their own crops for sowing. The tracts where seed depôts were first opened have become pure *Karungani* tracts and the depôts are now opened in new places each year. Messrs. Ralli Brothers have stated that " there has been a marked improvement in the quality of Tinnevelly cotton during the last few years especially in the Tuticorin circle " which is one of these tracts, and in two cases new ginning factories have been opened, in such tracts, on account of the good quality of the cotton obtainable there. In Kurnool, 18,700 lbs. of seed of white-seeded Tellapatti cotton were sold in 1910, and 50,000 lbs.—sufficient to sow 3,500 acres—was ready for distribution in the past year. At Coimbatore, *Cambodia* and *Bourbon* cottons have been crossed by Dr. Barber with a view to

obtaining a variety combining the best qualities of both. *Cambodia* cotton is being advertised as largely as possible by the Department and a large stock of seed is held. Seed has been widely distributed. From the Koilpatty station 2,353 and from the Palur Station 1,190 lbs. of seed were distributed in South and North Arcot, Salem and Coimbatore; it is also being tried in several districts in the north of the Presidency.

At Bellary selection of indigenous cottons is being carried out chiefly from the point of view of vigour of growth and percentage of lint to seed.

In the Central Provinces, plant to plant selection was begun in 1906, and has been continued uninterruptedly since: numerous crosses have also been made. Mr. Clouston, Deputy Director of Agriculture, in charge of the Southern Circle in this province, estimates that by selection he has gained from 2 to 3 per cent. in the proportion of lint to seed cotton. In Berar, as in Khandesh, a cotton of the *roseum* variety said to have been originally brought from the latter district, has proved most suitable, this cotton gives the high proportion of 39 per cent., and selected strains up to 40 per cent., of lint, and though the length is only half an inch, Mr. Clouston has pointed out in a recent article in the Agricultural Journal of India that when the yield of lint per acre is multiplied by the present price this type gives a much greater profit in Berar than any other. There are, however, great possibilities of improvement in *Malvensis*, a variety also of the Indian type of cottons but with a longer lint, and selection in this variety is proceeding. A variety called *Buri* of the American (*hirsutum*) type, and with lint about an inch in length has also proved suitable under certain conditions. Over 134,000 lbs. of seed of these three varieties have been distributed from 36 seed farms in Berar, and 6 in the Central Provinces during the year.

In the United Provinces, Mr. Leake is continuing his work in hybridisation and selection of Indian cottons.

In the Punjab, the sales by the Department of Agriculture of acclimatised American Dharwar cotton seed have become steady, but there is a fairly large area grown in the Canal Colonies. Selection of seed continues at Lyallpur.

Introduction of Superior Varieties from other parts of India.—In Madras *Cambodia* cotton, of the American Upland type, but introduced immediately from Pondicherry, has become a common garden crop in the south. It gives on irrigated land four or five times the yield of the dry land indigenous cottons and is worth more than the best Madras, and nearly as much as American cotton, bringing in a profit of Rs. 150 and more, per acre. The manner of its original introduction and the discovery of its value under irrigation are described by Mr. Sampson in Vol. VI, Part 4 of the Agricultural Journal of India. In Tinnevelly and Ramnad, whence its cultivation originally spread, wells are being sunk on all sides with the primary object of growing this cotton. The last crop was estimated at 33,000 bales of 400 lbs. valued at Rs. 6,000,000. This extended cultivation of a cotton of the American type is noteworthy as being the first time that cotton of this type has spread spontaneously on a large scale in India, and it opens the door to a wide field of improvement.

In the Central Provinces *Buri* cotton, also of the American type, obtained immediately from Chutia Nagpur, where it was found in cultivation on a small scale, has been found valuable as a wilt resistant variety.

The area of the cultivation of Broach cotton in the Southern Maratha Country has now increased to 5,000 acres. Both ginning percentage and quality of lint are better than those of the local Kumpta as well as the yield, but it requires sowing two months earlier. *Cambodia* cotton, referred to above as having proved so successful in Tinnevelly is also being introduced into the south-east of the Dharwar district where it has given promising results. Trials have been made at Nadiad in North Gujerat of three cottons, *Bourbon*, *Buri* and *Cambodia*, all of the American type. The first is a tree cotton and gave 400 lbs. of lint in the first and 1,000 lbs. in the second year of its growth. The two latter were sown in May and irrigated until the monsoon, and gave 1,100 and 800 lbs. of seed cotton per acre respectively. Samples of these three were valued at Rs. 400, Rs. 365 and Rs. 361, respectively, the latter being equal to fine Broach, and Professor Gammie points out that there is thus a

strong probability of at least three high class cottons being introduced profitably into Gujerat.

Trials of Exotic Varieties.—Besides the varieties *Bourbon* and *Buri* of the American type, which have been established on a small scale in India for a long time, and the Cambodia and Dharwar acclimatised varieties of the same type, a number of trials with new importations of American and Egyptian cottons, continue to be made. With the possible exception of Bourbon at Nadiad, tree cottons may be said to have failed everywhere in India. Egyptian cottons have been proved valueless at Lyallpur, though the varieties Ashmoni, Metafifi, Yanowitch and Abassi have been grown on up to the present year.

In Sind, also, *Abassi* has proved a failure, the staple having degenerated. *Metafifi*, produced on the Jamrao Canal has, however, for some years, been pronounced by leading cotton brokers in Alexandria to be of useful quality—up to the standard of "Fully Good Fair" Egyptian; which means that if properly cleaned, ginned and baled it would be classified as such in Liverpool; but there is no market for it in India and its brownish colour is against it. In view, however, of the proposed new perennial canals in Sind, one of which is to command over 1,000,000 acres, attempts at the creation of a market are being persisted in.

American Upland cotton can be grown in Sind on inundation canals, but owing, again, to the difficulty of its disposal, little seed has been distributed recently. Samples from six selected American varieties from Mirpurkhas have been valued in Liverpool at from 8·40*d*. to 11·5*d*. per lb. as compared with 8·2*d*. for "Middling American" and 7 $\frac{9}{16}$ *d*. for "Fine Broach."

In view of the great difference in quality of these cottons, it is clear that, should their cultivation ever become established, rigid selection both of the Egyptian and American types, which inter-cross freely, will have to be maintained.

Improved methods of cultivation.—The chief improvement to be recorded in cultivation of cotton is undoubtedly the practice of growing Cambodia cotton on well-irrigated garden lands

in Southern Madras, whereby, as already stated, a yield of 4 or 5 times that of dry land indigenous cottons is obtained. It is difficult to say how far such a system may extend, for while on the one hand the lengthening of season that it makes possible may increase the area in which long-stapled cotton can be grown, such cultivation cannot be indefinitely extended.

Skill in the method, introduced by the Agricultural Department in Tinnevelly, of sowing cotton in drills, is increasing, and over 1,600 acres were sown by this method in a week, after suitable rains.

(*b*) *Wheat.*—Satisfactory progress continues to be made in the development of high yielding and high quality wheats, and the testing of their behaviour in different districts and under different methods of cultivation. Five out of the six wheats which gave the highest yields, 30 maunds per acre and over, at Pusa in 1910, were of strains isolated there, and the wheat, Pusa No. 106, which headed the list with a yield of over 34 maunds, was selected from a cross made in 1906 between Pusa No. 6—one of the best quality rust resistant wheats hitherto obtained, but which sheds its grain early and so gives a relatively low yield,—and the white Muzaffernagar which gives a high yield but of poor quality.

Four of these wheats, Nos. 7, 8, 12 and 106, have been pronounced equally valuable with the best Manitoba wheat, their slight inferiority in quality being at least made up for by the greater dryness and thinness of skin characteristic of Indian wheats. Two other selections, from crosses made in 1906 between high quality and heavy yielding wheats, have been placed in the same class, and promise to yield equally as well, as No. 106.

Others again, of as good quality, give relatively small yields at Pusa, but have qualities such as earliness, and rust resistance which make them suitable for other districts or valuable as parents for crossing purposes, and two of these Nos. 6A and 7 have given the highest outturns among a number of wheats at Raipur in the Central Provinces, both on irrigated and unirrigated land.

There is thus now, at Pusa, a very wide range of wheats likely to be useful over a large area in India. Some of these are being grown at a number of stations in the plains, and several planters in Bihar have arranged an extensive trial of the new selections and hybrids, under estate conditions.

Three of the best quality wheats have been selected for work, at 10 stations, on the influence of environment on the milling and baking qualities, which is being carried out by Mr. and Mrs. Howard in collaboration with Mr. Leake, Economic Botanist of the United Provinces. From the work so far done in this connection, it appears that good cultivation has as much influence on quality as on quantity. The main lines of further improvement in Indian wheats are the development of strength of straw and rust resistance. The limit of yield that can be supported by wheats possessing straw of the strength of the best existing varieties, has been practically reached, and hybridization with wheats possessing strong straw but otherwise deficient is now in progress. As regards rust resistance, the problem is more difficult owing to the fact that, while none of the Indian wheats are resistant in anything like the degree of some of the European varieties, these latter will not come into ear at Pusa in time to be of any use. This difficulty has been got over with the assistance of Professor Biffen of Cambridge, to whom Mr. Howard sent several of the Pusa wheats for sowing in 1910. The resulting plants were crossed with rust resistant wheats at Cambridge in June of that year, Mr. Howard being granted deputation leave for the purpose, and the seeds so produced were successfully grown at Pusa, Cawnpore, and a few at Quetta, in the winter of 1910-11. There is thus every hope that India will soon possess real rust resisting wheats of high quality, the strength of the straw of which will enable them to support the heavy yield that they will give under higher cultivation. For a complete account of the work shortly reviewed here, bulletins Nos. 14, 17 and 22 of the Agricultural Research Institute, Pusa, should be referred to. The milling and baking tests on which the selection as regards quality has been based, have been carried out by Mr. A. E. Humphries, formerly President of the Incorporated National

Association of British and Irish Millers, who has taken a keen interest in the work and whose reports are published in the bulletins referred to. He also furnished the photograph used as a frontispiece to this report, of the best possible loaves he could make, from samples of Manitoba, Pusa, and the Muzaffernagar wheats grown at Lyallpur. This gives a clear idea of the improvement already effected and of the value of quality for the English market. As Mr. Humphries says, " no housewife would hesitate for a moment in her choice between the two Indian loaves."

In the Punjab, the wheat which was regarded by Mr. Humphries as the best in quality of the existing Punjab types, has again yielded far the best at Lyallpur, and has given a very heavy yield at Peshawar. This type seems to be a common ingredient in the mixtures grown in the Montgomery District. At Lyallpur most of the Australian wheats have been definitely rejected as not worth keeping, a few only being retained for crossing purposes. Crossing, selection, and testing for yield are being continued.

In the Central Provinces, experiments at Raipur have shown that the rotation of irrigated wheat and groundnut is a most promising one for irrigated tracts. At Hoshangabad, experiments have shown that the outturn is approximately doubled by two irrigations at suitable times. On this farm Mr. Evans has a large number of different varieties under trial, some of which are very promising, and the best will be tried on a large scale this year. Over 11,000 lbs. of selected wheat seed was supplied to seed farms principally in the Jubbulpore and Seoni Districts.

In the United Provinces the seed depôts continue to work satisfactorily. Nearly 13,000 maunds were distributed in 1910. A noticeable and satisfactory feature of the year was the extent to which cultivators saved their own wheat seed, which indicates a distinct advance in the economic position.

At Dohad in Bombay, experiments continue to show the superiority of introduced wheats over the local wheat on irrigated land. Plant to plant selection continues to be made, with special reference to rust resistance, and a survey is being

conducted of all the wheats of the Northern Division of the Bombay Presidency.

In Burma the extension of wheat cultivation in the Hills is being continued. Experiments in Bhamo, where it is hoped to be able to supply the Military police posts with locally grown wheat, were successful.

(*c*) *Sugarcane.*—A Note on Sugar in India by the Director-General of Commercial Intelligence, published during the year under review gives the statistical position of the sugar industry in India, and shows that while prices in India are rising generally, the price of sugar in the world has steadily fallen, resulting in a decrease in the production of sugar in India. Efforts continue to be made to meet the competition by the improvement of the cane and of its cultivation, and the progress made up to date in the various provinces is well summarised in the report of the Committee of the Board of Agriculture which dealt with this question.* In Mr. Noël Paton's note, above referred to, it is said that about half the area and quantity of sugarcane grown in India is grown in the United Provinces, one-quarter in Bengal and Eastern Bengal, one-eighth in the Punjab and one-eighth in the rest of India, but in the calculation of outturn it was assumed that the yield per acre was the same in Northern and Southern India, whereas in Madras and Bombay, the yield approximates twice that obtained in Northern India owing probably, to the longer season of the tropics, the better quality canes, and the more intensive system of cultivation thus rendered profitable.

In the United Provinces, work is in progress principally at Partabgarh, and is now chiefly concerned with the cultivation of the cane. A survey of the local canes is in progress, and a systematic trial of the chief local varieties has been undertaken. During the year a bulletin has been published by Mr. Clarke, Agricultural Chemist at Cawnpore, in which the conclusion is drawn that from 12,000 to 15,000 sets per acre planted at regular intervals are sufficient to ensure a maximum yield of sugar under the ordinary conditions of cultivation in the United Provinces, the yield obtained being about $2\frac{1}{2}$ tons of *gur* per acre.

* Proceedings of the Board of Agriculture in India, 1911.

At the Allahabad Exhibition, a small factory designed to turn out 1½ tons of white sugar in 24 hours, suitable for dealing with cane from 100 acres, was exhibited by Messrs. Blair Campbell and McLean. A description of the factory was published in the Agricultural Journal of India for July 1911. The chief points demonstrated were that a factory of this small size can be profitably worked, and that sugar suitable for direct consumption can be produced without any other clarifying agent than lime. The first point is of importance owing to the difficulty of getting a large area of cane grown within a small radius under present economic conditions in India, and the second on account of Hindu objections to the usual clarifying agents.

In Bengal, sugarcane is receiving an increasing amount of attention. A survey of the canes of the province has been conducted at Sabour with special reference to the percentage and quality of the juice and the period of ripening, and the results have been published, in a very concise form, in a "Departmental Record" by Mr. Taylor, Agricultural Chemist of the Bengal Agricultural Department. These results are of considerable importance, showing as they do that canes behave very differently as regards ripening, some ripening early in January and others late in March, at Sabour, and some having a long and others a short ripening period. There would thus seem to be a possibility of considerably extending the manufacturing period by the choice of suitable canes. The percentages of saccharose, in the canes tested, varied according to the variety of cane from under 12 to over 15. Experiments in the improvement of canes in this respect, by selection of cuttings from the richest plants, are also in progress. Field experiments have been continued on the Burdwan and Cuttack farms, and a large number of sets of a late ripening cane of high quality which was found to do very well at the latter station have been distributed in the district.

The members of the Behar Planters' Association have taken up the cultivation of sugarcane on a large scale, and good outturns have been obtained.

In Eastern Bengal, work has been begun at Dacca.

In Assam, sugarcane is receiving attention at Jorhat where imported and local varieties are being compared. *Striped Mauritius* cane has done very well giving a heavy yield of high quality, and is recommended as in every respect superior to the local variety. Two Barbados canes of very high quality give promise of becoming acclimatised.

In the Punjab, sugarcane is periodically damaged by frost. A survey of canes has been begun at Gurdaspur which is in a sugarcane tract. At Lyallpur, a yield of 30 maunds of *gur* per acre is considered good. Experiments in manuring are in progress.

In the North-West Frontier Province, local and imported varieties of cane are being tested.

At Manjri in Bombay, sugarcane continues to be the chief crop experimented with. As many people visited the farm with the object of learning the methods of sugarcane cultivation practised there, a class was started and 24 students attended. Trials and demonstrations of crushing machinery, boiling furnaces, and manures, were continued, but there is little to add to the results recorded last year. Cuttings of a disease-free cane are being distributed in Gujarat.

In Madras, the area of sugarcane is only about 3 per cent. of that in the whole of India, but the possibilities of extension are great because the climate is particularly suitable, the local canes are inferior, and irrigation is extending. The *Red Mauritius* cane continues to make rapid progress in South Arcot; the demand for sets for planting has been greater than the supply, and over 2,000 acres have been planted with this variety—more than 96 per cent. of the total cane area. In fact local canes, both here and in Godaveri, can be said to have practically disappeared. The canes known as *Ashy Mauritius* and Barbados 208 have also done very well in South Arcot. In the vicinity of Nellikuppam the area of *Red Mauritius* cane has grown to 2,250 acres since it was first introduced by the Department of Agriculture from Melrosapuram. On the West Coast also, trials of small plots of this cane are being made over a large area, chiefly in South Canara, and it has done better than the local

varieties everywhere. The cultivation of sugarcane recently introduced into Malabar is expected to spread rapidly.

Experiments at several agricultural stations confirm the opinion that want of attention to drainage is the greatest defect in the ryot's method of cultivating sugarcane.

In Mysore, three of the four local varieties of cane have been found, on testing chemically, to be exceedingly good canes. Nahan bullock mills have been found superior and are being introduced, and four or five three-roller horizontal mills, driven by oil-engines, have been set up with very satisfactory results. One refinery, in a fine cane growing tract, has found it impossible to get guarantees from cultivators of sufficient cane at a fixed price.

In the Central Provinces, two stations have been opened, in newly irrigated tracts, mainly for the study of sugarcane, which appears likely to be an important crop in the irrigated parts of the Wainganga tract. At Raipur imported and local canes are being tested.

(*d*) *Tobacco.*—The growing demand for cigarettes in India and the higher duties on tobacco are likely to increase the importance of this crop.

At Pusa, Mr. Howard has found green manuring with Sann-hemp (*Crotalaria juncea*), if carried out in good time, as effective as the organic manure usually employed, and cheaper. Both the yield and quality of the leaf grown on this system were satisfactory. This has been brought to the notice of tobacco growers and extensive trials are being made in the district. The curing experiments which are being conducted in collaboration with the Peninsular Tobacco Company of Monghyr, promise useful results particularly with selected Indian tobaccos. Information bearing on this aspect of the work was collected by Mr. Howard from some of the best factories in England, which he visited while on deputation leave. Mrs. Howard has made considerable progress with an investigation of the inheritance of characters in this crop, with a view to its improvement by hybridisation—practically nothing being known on the subject hitherto.

As regards the work at Burirhat in Eastern Bengal, the following is quoted from the Annual Report of the Agricultural Department of that Province :—" Tobacco work at Burirhat has followed two lines, *viz.*, the production of—

(*i*) a high-grade cigar wrapper leaf;

(*ii*) tobacco suitable for good class cigarettes.

" For the first purpose the Sumatra variety was grown, and, where the soil was in fairly good condition, excellent results were obtained. From one block of 1·10 acres 1,404 lbs. of leaf were sold for Rs. 1,558-8-0 and the cost of cultivation and curing was only Rs. 246-9-9 (exclusive of rent and value of cow-dung, which would probably be covered by the price of the lowest grade of leaves, not yet sold). These returns are not only highly satisfactory in themselves, but the prices are also far in excess of any hitherto obtained for tobacco grown in Rangpur district, and probably higher than any ever realised for Indian grown tobacco.

" For the second purpose *Little Flemingan*, *White Burley*, *Connecticut seed leaf*, and some Turkish tobaccos were fire-cured. Seven maunds of *Little Flemingan* were sold for Rs. 35 per maund, the total cost of production being about Rs. 23. Some other varieties realised even better prices, *White Burley* selling for Rs. 37-8-0 and a small lot of Turkish tobacco for Rs. 81-4-0 per maund.

" It cannot be doubted that the prices realised indicate that there has been a marked improvement in the quality of the tobacco produced at Burirhat. Though the variations in the import duty make it difficult to gauge the extent of the improvement, yet the fact remains that tobacco is now being produced of a type which meets the requirements of Indian manufacturers of cigars and cigarettes. There is ground for hope that such further improvements in quality may soon be effected that Burirhat tobacco may be acknowledged as the equal of good grades on the English market."

In Madras, Mr. Barry, who leased land from Government for the purpose, grew 150 acres of exotic tobaccos. In spite of a most unfavourable season good crops were obtained on part of the land. The most interesting feature was the success of the

plots green-manured with Sann-hemp and wild indigo which confirms Mr. Howard's experience of the peculiar value of green manuring for this crop.

At Nadiad in Gujarat, six American and two Turkish cigarette tobaccos have been tried, but the samples of cured leaf sent to the Peninsular Tobacco Company were not considered suitable for cigarettes.

(*e*) *Groundnut.*—This crop is grown chiefly in Madras, Bombay and Burma. In South Arcot, in Madras, the area grown is about 250,000 acres. The yield both of irrigated and unirrigated groundnuts has fallen off in recent years. In experiments at Palur Agricultural Station in which groundnuts are grown continuously on the same land the yield in spite of manuring has fallen off by 50 per cent. in two years, and it seems probable that the general falling off in yield is due to the too frequent growth of this valuable crop. *Cambodia* cotton is proving a promising substitute, which may enable groundnuts to be grown at longer intervals, and these crops are thus likely to be mutually beneficial, as the groundnut improves the land for the cotton. Experiments at the same station continue to show the advantage of growing a cereal crop mixed with groundnut, the outturn of groundnuts in the last year having been actually higher on plots on which a cereal was also grown than on plots on which groundnut was grown alone. Manurial and variety experiments are also in progress.

The cultivation of groundnut is extending on the West Coast.

In the Bombay-Deccan, the area of this crop, after falling from 164,000 acres in 1895 to 56,000 in 1902, has risen again to 127,000 acres in 1909-10. This is probably partly due to the extensive adoption of exotic varieties which require less water and yield a heavier outturn than the indigenous variety. Over 18,000 lbs. of seed of exotic varieties were distributed in the year.

In the Central Provinces, groundnut is becoming very popular in Chhattisgarh, its production has already overtaken the local demand, with the result that prices have fallen.

In the United Provinces, the crop has been shown at Aligarh to be very profitable when grown with maize and this system is being recommended to cultivators. Nearly 150 maunds of seed were distributed in the last year, and the crop has met with striking popularity wherever so far introduced.

The crop has also made considerable progress in Orissa.

In Eastern Bengal, trials have been made on a small scale but much loss was caused by rats, and the same difficulty has been experienced in Bihar.

In Burma the area of this crop has declined, but it was grown on over 100,000 acres and is considered to have been established.

(*f*) *Fibre Crops.*—(*i*) **Jute.**—A considerable amount of work has been done during the year in connection with botanical questions affecting fibre crops. Messrs. Finlow and Burkill have written a Memoir, which is in the press, in which it is shown that the jute plant is normally self-fertilised. Occasional crossing in the field occurs sufficiently often to account for the origin of all the known types of variation; such crossing is, however, apparently too rare to add seriously to the difficulty of introducing improved races of jute into districts where other races are already grown. Selection of plants with a view to the improvement of the fibre is being continued at Dacca, and a final account of the work of classification of the races of jute in Eastern Bengal and Assam has been prepared and is about to be published.

Mr. and Mrs. Howard have published two Memoirs giving an account of their studies in Indian fibre plants. In the first, two distinct varieties of Sann-hemp (*Crotalaria juncea*) are described, an examination of one of which, obtained from Jubbulpore, indicates marked superiority of fibre both in strength and durability. The occurrence of these distinct varieties shows the desirability of conducting a survey of the crop grown in the various provinces of India, and steps have been taken to do so at Pusa. In the second Memoir five varieties of *Hibiscus cannabinus*, comprising eight agricultural types, are described; cross-fertilisation is shown to be very common, and a method of

keeping the crop pure, by *roguing* in the seedling stage, is suggested.

(*ii*) **Flax.**—During the season 1909-10, fifty acres of flax were grown at Dooriah, the straw from which was worked up in the following season and produced 188 maunds of flax with 124 maunds of tow and 184 maunds of seed. Mr. Vandekerkhove estimated the profit at Rs. 60 per acre, valuing the flax at £60 and the tow at £18 per ton and deducting all charges for freight, etc. These results were published as a Bulletin, No. 25 of the Pusa Research Institute, so that anyone who wished to start growing flax on the strength of the estimated profit might do so in the next two years during which Mr. Vandekerkhove will be on the spot to give advice. Since the publication of the Bulletin the whole of the tow has been sold at £29 per ton, and part of the flax at £68 per ton, in Belgium.

In the season 1910-11, about 77 acres under flax at Dooriah yielded 47 maunds of straw per acre, as against 40 maunds in the previous year.

Experiments carried out by Mr. H. Lawrie at Baihata, Assam, resulted in the production of 35 maunds of straw per acre, but the cost of labour is likely to make the successful production of fibre, there, difficult.

The experimental cultivation of flax is being taken up by the Agricultural Department in the United Provinces where preliminary trials have already indicated the possibility of good crops on irrigated land. The manurial experiments at Pusa have been abandoned, owing to the presence of dodder. Experiments in importing seed from Europe indicate that if it is specially dried it can be safely imported in barrels; this method is much cheaper than packing it in sealed tin-lined boxes, but the seed still costs Rs. 19 per maund.

Attempts to grow seed at Shillong were not very successful, but at Ootacamund a fair yield was obtained. If seed could be grown without deterioration, in India, a very great saving would be effected, as the seed rate for flax is nearly a maund per acre.

(*iii*) **Agave.**—The Government *Agave* plantation at Hindupur in Madras has been given up, the cost of extraction of the fibre by hand having proved prohibitive, and no small portable machine suitable for use by unskilled labourers being obtainable.

(*g*) *Rice.*—Owing to the enormous number of varieties of rice in India, their systematic investigation and classification has never hitherto been attempted. A collection and rough classification of those of the Bombay Presidency was begun by Mr. Holmes-Smith in the year under report and will be carried on by Mr. Burns, Economic Botanist in Bombay. At Lonavla, investigations into the "rab" process of burning cowdung, etc., on the seed bed have been continued, and a Memoir on the scientific aspects of the subject has been published by Dr. Mann and Messrs. Joshi and Kanitkar. The field experiments carried out by Mr. Knight have shown that a large number of nitrogenous manures produce a greater weight of seedlings which will plant out a larger area than those grown under the *rab* system and at about a sixth of the cost per acre, but in almost every case the seedlings grown by *rab* ultimately give a higher yield per acre than those grown otherwise.

In Madras, the chief work with paddy continues to be the demonstration of the advantage of single transplantation from thinly sown seed beds. The advantage is seen not only from the saving of seed and the increased yield per acre obtained, but in the appearance of the fields; singly planted fields having a greener appearance and showing more vigorous growth than those planted in the usual way. The saving of seed alone is about Rs. 3 per acre planted. A large area, roughly estimated at 7,000 acres, was planted in this way in 1910, in Tanjore; and many land-owners, while afraid to adopt the system at once, are reducing their seed rates.

Green manuring with Sann-hemp (*Crotalaria juncea*), Dhaincha (*Sesbania aculeata* and *ægyptica*) and wild indigo (*Tephrosia purpurea*) is also being vigorously advocated.

The advantages of the practice, where the seed can be sown in the standing paddy crop or where water for sowing can be

obtained later, are very great; the cost being from Rs. 1-8-0 to Rs. 5 per acre; whereas a relatively small amount of leaves carried on to the fields, as is the present practice, costs some Rs. 10 to Rs. 25. Nearly 1,000 maunds of seed of these plants, sufficient to sow over 6,000 acres, was sold, chiefly in the Tanjore and South Arcot districts, during the year. Milled fish, bonemeal and superphosphate have all been found useful manures for paddy in Madras, but potash and nitrates have been failures, the former lowering the yield.

In the Central Provinces, it is believed that nearly 6,000 acres of paddy were transplanted, under the advice of the Agricultural Department, in 1910; but, owing to enhancement of water rates, extension is becoming more difficult, as transplanted rice requires irrigation.

In Bengal, surprising results have been obtained with the application of sulphate of magnesia to paddy at Bankipur and the point is receiving further attention.

Experiments at Dumraon continue to show the advantage of the practice, called *Nigar*, of draining the water out of the fields at the end of September and reflooding after a fortnight. The farm at Burdwan is being devoted mainly to the demonstration of the value of the use of small quantities of bonemeal and saltpetre on paddy in that neighbourhood.

In experiments at Dacca, bonemeal at the rate of three maunds per acre has given excellent results, not only in the year of application but in the subsequent year. Soluble nitrogenous manures were not successful.

In Burma, over 700 acres, in Akyab, are reported to have been sown with the Moulmein paddy, introduced by Government into the district, and large quantities of grain have been disposed of at higher rates than in the previous year. The chief varieties of paddy in Upper Burma have been classified at the Mandalay Agricultural Station.

(*h*) *Tea, Coffee and Rubber.*—The note prepared by the Director General of Commercial Intelligence, on the production of tea in India in 1910, shows that, while the area has increased by 98 per cent. since 1886, the production has gone

up by 266 per cent. This is *primâ facie* evidence of a very great improvement in cultivation, and, with prices rising, strenuous efforts are being made to increase the production per acre by all possible means. Over three-fourths of the tea grown in India comes from Eastern Bengal and Assam. Large profits were made in 1910, and progress is being made in every direction except as regards supply of labour. The labour difficulty is not however an unmixed evil, as it prevents too rapid extension and a consequent fall in prices.

The Indian Tea Association, until March 1911, maintained a station at Heeleaka for the work of the Scientific Department subsidised by Government. This station has now been abandoned, and a site for a new and enlarged station has been selected at Tocklai near Jorhat. Two bungalows and a laboratory are expected to be shortly completed here, and an Entomologist and Mycologist are about to be appointed. During the year, advice has been given to agents and managers regarding improvements in cultivation and manufacture and the prevention of blights. Pamphlets on Mosquito and Blister Blights were issued. A note on blister blight by Mr. W. McRae, now Mycologist to the Government of Madras, has been published, and also the final report on the Heeleaka Experimental Station, and a note on the cultivation of Tea Soils, both by Dr. G. D. Hope, M.A., Ph.D., the Scientific Officer of the Association. Dr. Hope has also started a new Quarterly Journal containing matter likely to be of general scientific interest to those connected with the tea industry.

In accordance with a scheme adopted in 1910, members of the United Planters' Association of Southern India, are carrying out a large number of experiments on coffee, rubber and tea, the results of which are published from time to time in the *Planters' Chronicle*. The appointment of scientific assistants, who may take charge of such experiments, is under consideration.

A laboratory has been fitted up, adjoining the office of Mr. Anstead, the Association's Planting Expert. The most important piece of work done during the period under review was the investigation of a method for controlling Pink Disease

(*Corticium javanicum*), a fungoid disease of Hevea rubber. Painting the forks of the trees with Bordeaux mixture, in the dry weather, has been found a completely successful method of preventing the occurrence of the disease.

Large areas of Hevea rubber have been planted in the last few years in Burma where the climate is suitable, though not so ideal as in moister tropical regions.

One of the chief features of progress in plantation work is the increasing amount of attention that is being given to the growing of green manuring and cover crops, and there seem to be great possibilities of the extension of this system in conjunction with the use of mineral manures providing phosphates and potash where necessary.

(*i*) *Indigo.*—The disastrous flood at Sirseah in 1910 destroyed almost the whole of the results of the last two years' work on indigo, only a few plants grown for selected seeds having been saved in pots. Analyses, of a large number of "Java" plants, made before the flood came, showed that the variation in the indigotin yielding power of different individuals was very great. Out of 100 similarly grown plants, analysed within a fortnight, the highest was found to be capable of yielding ·79 per cent. and the lowest only ·34 per cent. of indigotin, and the inference is that, by selection, the average yield should be capable of being raised to the level of that of the best plants—which would mean an improvement of the order of 50 per cent. Selection, with this object in view, has been begun again.

As regards manufacturing processes, it has been found that a paste of suitable concentration in indigotin can be made direct from the "mal" by partial pressing, and that it can be preserved by previously mixing an antiseptic with the "mal." The best means of bulking and repacking these pastes so as to obtain a uniform product is at present under consideration.

2.—*Special subjects.*

(*a*) *Agricultural Education.*—When the Provincial Agricultural Colleges and that at Pusa were founded, it was intended

that students who had completed their course at a Provincial College and who showed sufficient ability in any one branch of Agricultural Science, might continue their studies at Pusa in that branch. The Provincial Colleges have not yet been at work sufficiently long to send any such post-graduate students to Pusa, and it is becoming increasingly evident that owing to the limited demand for agricultural scientists in India, the number of those who avail themselves of the advanced courses there, is likely to remain small. There are now six such students at Pusa. Meanwhile, the short practical courses in subjects which are not at present taught in the Provincial Colleges continue to be popular, and were attended by 46 students during the year.

The main College buildings at Poona have been completed and only the students' hostel now remains to be finished. Of the 104 students at the end of the last College year, nine-tenths intended to take the Agricultural degree of the Bombay University. There were only five students for the College diploma who were not admissible to the University examination. Thirteen students have attended the short practical course started two years ago for the sons of farmers and landowners, and this is perhaps, as far as agriculture is concerned, one of the most promising features of the College work. Fifteen scholarships per annum, lasting for the three years of the course, are offered by Government, and these attract boys of the cultivating classes, who however seldom have the capital necessary to enable them to utilise the education so obtained on their own account, and so become dependent on obtaining Government service. The students have, on the whole, been very successful in obtaining employment, and some of them are taking up farming as a profession.

The vernacular Agricultural School opened in Poona in 1910, at Dr. Mann's instigation and under his supervision, for boys of substantial village families, was joined by 21 boys between 13 and 18 years of age. The course is largely practical, half the time being spent in the field; on farm, gardening, dairying or other agricultural work. The remainder is devoted to such subjects as arithmetic, reading and writing,

hygiene, and village economics. A large number of applications for admission have been received, and 18 suitable boys between 14 and 16 years of age have been selected for the second year's class. The school is considered to be a success, and it is intended to start similar schools in the Southern Maratha Country, Sind, and Gujarat.

The first batch of students at the Madras Agricultural College at Coimbatore finished their course at the end of the year under report. Fourteen out of 16 who appeared for the examination obtained the diploma. Mr. Clouston, Deputy Director of Agriculture of the Central Provinces, who examined them, reported that they had a wide and accurate knowledge of agriculture. About half are the sons of land-owners, who will use their knowledge on their own estates; only a few will be required to fill the vacancies in the Agricultural Department. It is expected that this will tend to maintain the standard of the students; as experience at Saidapet has shown that an Agricultural College which is degraded into a training school for Government officials in the Revenue Department; soon ceases to attract the best class of students, men connected with the land.

Satisfactory progress has been made with the new laboratory buildings at Nagpur; of 18 third year students, 4 gained the L. Ag. degree, 9 the diploma, and 5 failed. Of the passed students, 10 are joining the Central Provinces Agricultural Department. It was found that the relaxation of the Matriculation test in favour of the sons of cultivators was not a success, only 3 men out of 12 so admitted having been retained. This is only what would be expected having regard to the nature of the curriculum of the three years' course. On the other hand, the few agriculturist students who have matriculated are said to be the pick of the recruits.

The Nagpur Malguzari class has come to an end with the withdrawal of scholarships, which appeared to attract only candidates for an easy means of access to service in Tahsils and District offices. Practical instruction in definite improved local methods with the minimum of explanatory theory, such as is given at Raipur as regards rice transplanting, appears to be

more useful, and a similar class is being opened at Hoshangabad.

A feature in agricultural education in the Central Provinces is the development of the training of *kamdars*. Men who are literate in the vernacular and thoroughly understand the respective branches of agriculture on which they are to be employed, are trained in special methods of cultivation that have been demonstrated as successful in the area in which they live, and are found capable of doing very useful work under the agricultural assistants. One or two have reached a degree of proficiency that has enabled them to be placed in independent charge of their circles. A similar course of training is offered to Court of Wards employés. The training classes at Raipur and Hoshangabad are becoming increasingly popular, and meet a genuine demand from private estates for trained employés.

The College at Sabour in Behar was opened in November 1910. It has been decided to continue the agricultural classes at Dumraon and Gaya High Schools for three years to give the boys who have already started the course an opportunity of finishing it; but it is admitted that such classes are of no practical value, and an effort will be made to introduce the method of nature study and the study of plant life, in all schools, under the supervision and direction of the Education Department. An experiment is to be tried in the Orissa Division, of giving prizes from the funds of the Agricultural Department to *gurus* and students, to encourage the adoption of the method of nature study.

The practice of training sons of cultivators at experimental farms is being continued. At Cuttack an Overseer and four student cultivators received practical training during the year. Such students receive free quarters at the farm and are paid as farm labourers at the ordinary local rate. Enquiries for trained men have been received from land-owners, and district agricultural associations are invited to send men for training.

In Eastern Bengal and Assam a scheme for training teachers in nature study for primary schools has been sanctioned, and work has been begun at Dacca. The Education Depart-

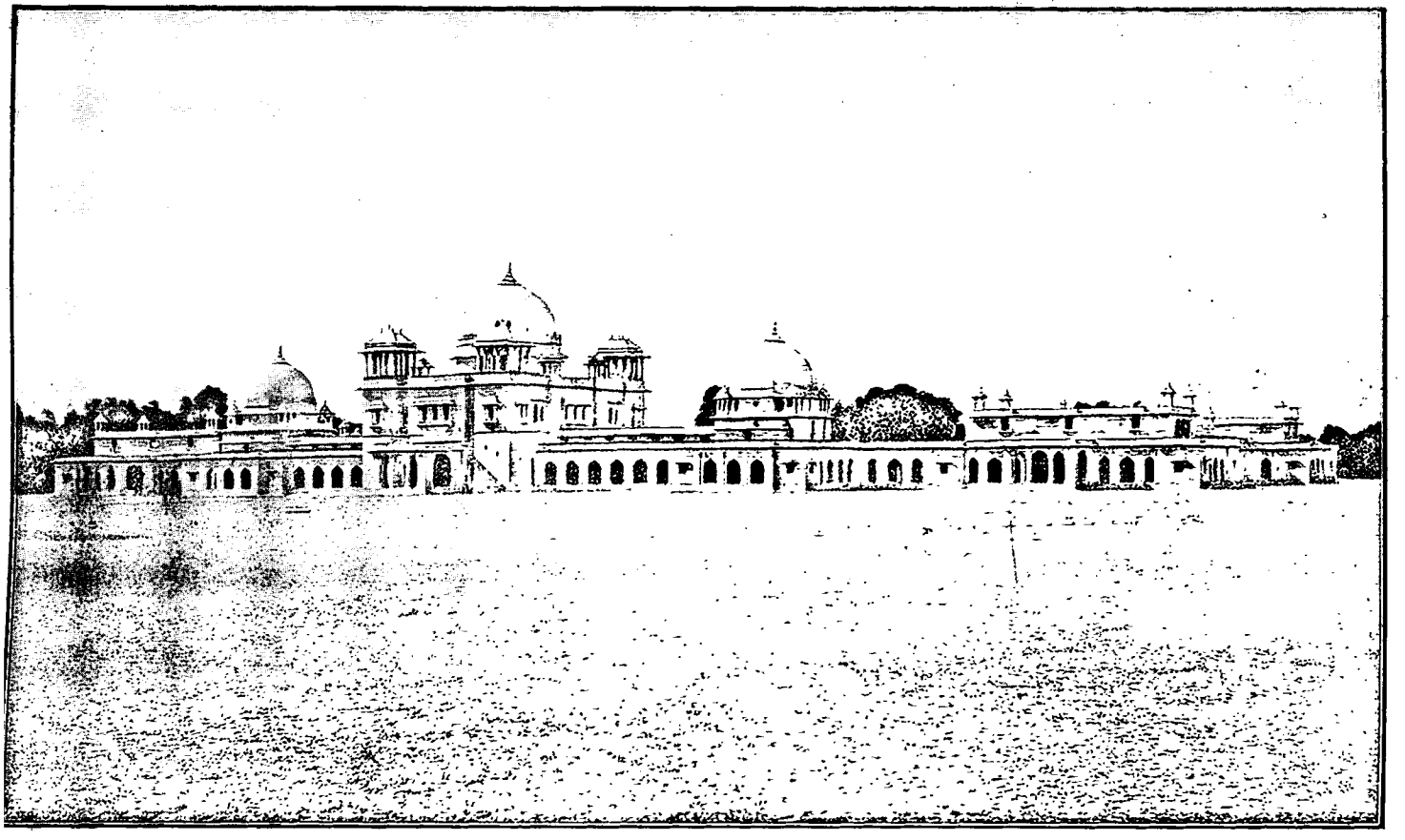

Photo.-Engraved & printed at the Offices of the Survey of India, Calcutta, 1912.

AGRICULTURAL COLLEGE, CAWNPUR.

ment is providing gardens for primary schools, and a curriculum has been framed in which objective teaching is emphasised. Apprentices are trained at the agricultural stations for employment as fieldmen demonstrators, but the Department has not been in a position to give sufficiently thorough training hitherto, and improvements are to be effected.

At Cawnpore, the more promising applications for admission to the College indicate that the proportion of students connected with the land may increase. The College, of which a photograph is reproduced opposite, has been recently formally opened.

It has been decided that direct agricultural teaching in the primary schools of the Province would be out of place, and the course should not go beyond object lessons and nature study. As an experiment, a scheme of object lessons dealing with insect life, of which the life-history of Eri silk-worms has been selected as an example, has been drawn up by Mr. Moreland and accepted by the Director of Public Instruction, for introduction in certain schools in Shahjahanpur.

Students from the classes at Saharanpur and Lucknow for head gardeners, have no difficulty in getting remunerative employment.

The Punjab Agricultural College at Lyallpur was opened in December 1910. There are now 65 students at the College, of whom 30 are in the first year. The Director of Agriculture reports that most of these have no object except to get Government service, and that the College is not popular in the class which it is wished to attract.

In Burma a scheme has been prepared for the creation of a staff of district vernacular agriculturists recruited mainly from the Settlement and Land Records Department, to serve as intermediaries between the Agricultural Department and the Co-operative Societies and general public.

A perusal of the reports of the Provincial Departments leads inevitably to the conclusion that while the Agricultural Colleges are patronised to a large extent by candidates for Government employment the number of agriculturists who value a scientific education as a preparation for an independ-

ent career for their sons is very small. Moreover the number of passed students who can find employment in the Agricultural Department on a scale of pay commensurate with the standard of education provided, must always be strictly limited and the colleges must therefore look to the Revenue Department to provide a demand, if they are to become popular. This means that until agriculturists begin to put a higher value on scientific training, the colleges will merely be providing a substitute for a general education. On the other hand, there is undoubtedly already a large demand both on behalf of the Agricultural Departments and land-owners for vernacular speaking and writing agriculturists who have received what may be called a purely technical training in agriculture, and it is the experimental farms that must provide the basis of all such instruction by evolving the methods to be taught.

The uselessness of attempting to teach agriculture as such in primary and secondary schools is acknowledged, but there is an almost universal feeling that the present instruction in rural, primary and secondary schools could be very much improved, with the object of not unfitting boys for agricultural life, by the widening of the curriculum, especially on the scientific side, so as to make it less academic and literary and more applicable to and explanatory of the boys' every-day surroundings. Attempts at improvement in this direction generally take the form of introducing what for want of a better term is called "nature-study" into the curricula of a few schools, but in the absence of any action on the part of the University Syndicates and the Departments of Education very little progress is likely to be made. If there could be prescribed some wider test of the general intelligence which such an alteration in education is intended to develop in candidates for the Matriculation Examination, the various tentative schemes of educational improvement in rural schools that are from time to time put forward would be tried on their merits, and could be extended or abandoned without the feeling of regret that now attaches to the failure of deserving efforts in what is apparently the right direction. It would perhaps not even be too much to expect that in the construing of the term "width" as

applied to the culture of educated Indians, the fact of the predominance of agriculture in the interests of the whole community might receive free recognition; by the inclusion, for example, in the curricula of secondary schools, as compulsory subjects, of certain of the sciences which deal with the principles underlying the practice of agriculture. The gap in the scheme of education which now exists and renders the ordinary student unprepared to enter an Agricultural College, would thus be filled up.

(*b*) *Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures.*—The distribution of seed and implements is here included under the head of demonstration of improved methods, as experience is showing that the mere distribution of seed and implements without further organisation on the part of some central authority is not usually, or even commonly a very successful means of introducing improvements. In England seedsmen look after the maintenance of pure seed, and keep their customers informed as to any peculiarities of cultivation required by improved seed; and implement makers provide a large choice of similar implements suitable for various conditions, and supply catalogues of spare parts, etc., etc. Under present conditions in India such information and assistance, even if provided in the first instance by business firms, has to be interpreted and brought home to the cultivators by a more direct agency, and pending the extensive development of co-operative societies this duty devolves upon the Agricultural Department.

In Bombay the agricultural stations are unable to perform these duties effectively for the large area through which they are scattered, although they do to a great extent perform the functions of dealers in seed, implements, and manure. Agricultural Associations now number 38, 6 new ones having been created during the year, but there are difficulties in providing funds and sustaining interest and continuity in the work, which generally depends for success on the energy of the private individual who has organised the association. In some tracts iron ploughs are becoming popular, the people in one village in

Sholapur have bought 80, and there have been demands for ploughs costing as much as Rs. 60. Considerable quantities of cotton and groundnut seed were distributed during the year, and there has been some demand for nitrogenous manures, oil-cakes, and sulphate of ammonia, for sugarcane. The necessity for some reliable agency for seed distribution is emphasised in Mr. Keatinge's report.

With the development of demonstration work in Madras, consequent on the introduction of established improvements, much more touring has become necessary for the officers attached to agricultural stations. In addition to those stations, which act as the distributing centres for implements and seeds, depôts for the sale of improved seeds are opened in districts where there is a demand. In Tinnevelly, 43 such depôts sold Karungani cotton seed sufficient for 14,000 acres in the year. Cultivators are now keeping their own seed of the improved stock for sowing, and depôts are being opened in new places every year. This is an instance where extensive operations on the part of the Agricultural Department have resulted in completely replacing an inferior by a superior type of a staple crop in a few years over large tracts, and the effect on the market has been attested by three of the largest cotton exporting firms. In addition to this and Cambodia cottons, large quantities of seeds of improved groundnut, paddy, and green manuring crops, as well as sugarcane sets, have been distributed from the argicultural stations in the Southern Division. In the Northern Division, two seed farms have been started to grow seed of the cotton selected at the agricultural stations, and 25,000 lbs. of seed were sold.

The popularity of the archimedean screw for lifting water to a maximum height of 4 feet, and of the Sind plough and triangular harrow, is increasing. The manufacture of the archimedean screw has been taken up by local firms in Tanjore and Trichinopoly, and two European firms manufacture iron ploughs, of which a fair number have been sold. A cheap and effective winnower is badly wanted.

In the Central Provinces the agricultural associations take a prominent part in the demonstration work of the Depart-

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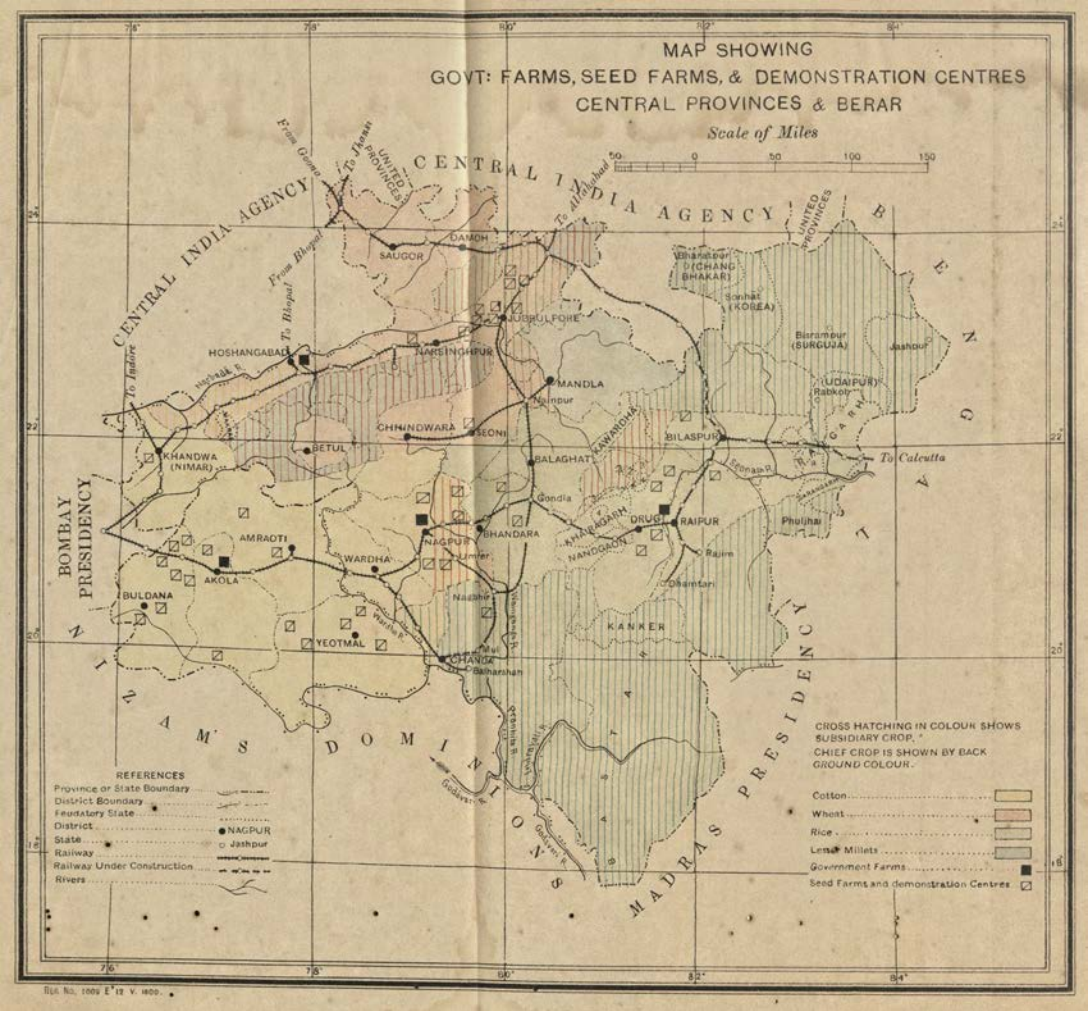
OF THE
ROYAL



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ment, working in close touch with the officials. The members seem to be, perhaps on account of this official support, enthusiastic and useful, and provide in one case the necessary funds for local agricultural shows. The training of *kamdars* for demonstration work in this Province has already been referred to; they are being employed more largely as time goes on in the rough work of demonstrating in the ryots' own fields the system of transplanting rice, in Chhattisgarh. The organisation of seed distribution in the Central Provinces is largely based on co-operation between the Agricultural Department and private individuals, principally members of agricultural associations, who grow and supply the seed of improved stocks obtained from the agricultural stations, and in many cases demonstrate the use of new implements as well. Twenty-one new such seed farms have been established in Berar, bringing the total up to 42. The seeds distributed are of several varieties of cotton and of jowar (Sorghum). In Hoshangabad wheat seed is distributed in a similar manner, selected agents purchasing the seed from the Government farm at Powarkhera and selling the produce, for seed only, under official supervision. In the last year, six large seed farms grew the white wheat, *sukerhai pissi*, distributed from Hoshangabad and 18 more, of not less than 25 acres each, were about to be started. A reference to the map opposite shows that the centres of activity of the Central Provinces Department of Agriculture are now well distributed over the greater part of the principal crop producing tracts, providing a system by which any established improvement can be rapidly disseminated throughout the Province.

There is little progress in demonstration work to record in Bengal, where, as in the Punjab, there is only one Deputy Director free from College work, and he has hitherto had charge of six experimental farms scattered over the Province, and has naturally had little time to attend to other work. Members of the agricultural associations have the advice and assistance of Divisional Inspectors, and seeds and implements are distributed on a small scale from the central seed store and through the experimental farms.

In Eastern Bengal and Assam, the most important demonstration work has been the application of bonemeal on rice land near Dacca, as a result of which some cultivators are roughly grinding bones to apply to their fields. The value of green manuring for paddy and tobacco has also been demonstrated, and there is some demand for seed for this purpose. Seeds of paddy and jute, and potatoes and sugarcane sets, have been distributed on a small scale from the seed depôt, and a few implements, chiefly Planet Junior hand hoes, have been sold.

In Burma no demonstration work has hitherto been undertaken, for lack of staff. Seed has, however, been supplied to many persons, and a scheme for the supply of improved implements has been sanctioned. The appointment of the Director of Agriculture as Joint Registrar of Co-operative Credit Societies, leading to closer relation between the Agricultural Department and the cultivators, is likely to facilitate demonstration work when the time comes for its extension.

In the United Provinces the idea of demonstration farms maintained at Government expense has been deliberately discarded. Demonstrations are carried out on plots of land belonging to land-holders in widely separated localities. Operations are at present limited by the number of officials with sufficient experience to supervise the work; but there are a sufficient number of subjects for such demonstrations, including methods of sugar manufacture, a method of securing proper spacing in the sowing of maize, the simultaneous cultivation of maize and groundnut, the sowing of cotton in lines, and the use of cotton cake as cattle food. Agricultural associations in some districts give a certain amount of assistance in demonstration work, but the chief means of disseminating improved seeds are the depôts, from which a large quantity of wheat seed is distributed yearly. Seeds of groundnuts and of varieties of *rahar* and cotton, as well as sugarcane sets, have been distributed from the experimental farms in considerable quantities. A private seed farm at Sisauli, worked by a diplomate of the Cawnpore Agricultural School, supplied 600 maunds of Muzaffernagar wheat, for Egypt, in the past year.

Considerable development has taken place in enquiries for, and the means of supply of implements as the result of the Allahabad Exhibition. A list is to be maintained of recognised dealers in implements to whom preference will be given in distributing orders, in order to encourage the maintenance of stocks at convenient centres, and thus open the way for direct dealings between sellers and users. Private firms have taken up the manufacture of chain-pumps, and also of Meston and Watt's ploughs, which have therefore ceased to be made in the departmental workshops. A certain number of depôts, the management of which has been undertaken by private persons, have done useful work in distributing implements. Altogether 550 iron ploughs and smaller numbers of chain-pumps, maize-shellers, chaff-cutters and kibblers have been sold during the year. In the last three years pans and machinery for sugar production to the value of Rs. 1,17,000 have been sold, including 31 centrifugals; manufacturers are also selling the latter without the Department's intervention.

In the Punjab, very little demonstration work is possible with the limited European staff available, there being only one Deputy Director who is free from work in connection with the College. A certain amount of seed is distributed, chiefly of *Dharwar* cotton. Implements are sold in the Punjab by Messrs. Volkart Bros. who have disposed of 51 reapers and 150 "Rajah" ploughs in the last year. There is also a fair demand for fodder-cutters and harrows. Assistance in the use of these implements is given to the purchasers by the Department's officials working under the Deputy Director. A winnower has been designed, and obtained a gold medal at the Allahabad Exhibition, which is capable of dealing with an average of a ton of *bhusa* per hour—giving from 6 to 9 maunds of grain, and a limited number of these machines have been imported by Messrs. Volkart Bros. With the assistance of Messrs. Ransome, Sims and Jefferies' expert, a simple and efficient steam threshing machine has been evolved, but the cost is Rs. 4,500, including the portable engine.

(*c*) *Irrigation.*—The fact that in no part of India is the rainfall sufficient to maintain field crops in full growth, all the

year round has always been a serious handicap to Indian agriculture as compared with that of moister regions in the same latitudes. The shortening of the growing period of a crop means a proportional loss of return for the labour put into the preliminary cultivation of the land which is well illustrated by the difference in the outturn of sugarcane in Madras and in the United Provinces,—a difference between maxima of 4 and 2½ tons of sugar per acre caused by the termination of the growing season of the crop by cold in Northern India.

The economic advantages of irrigation are therefore perhaps as great, though not so obvious, in Southern India, where it is only necessary for relatively short periods, as in the North-West where it is often impossible to grow crops without constant irrigation. The success which has attended the growth of Cambodia cotton in Madras on irrigated land, by which system the season is extended so as to admit of the maturing of a heavy crop of long stapled cotton, is an instance to the point. As previously mentioned, numbers of wells have been sunk in Tinnevelly with the primary object of growing this cotton, and this extension of irrigation means an economic advance that is not reflected merely by the figure of Rs. 60 lakhs representing the value of the last year's crop. Well irrigation means more capital, more thrift, and steadier profits for the cultivator; and, where it is combined with the use of an oil-engine for lifting the water, it means little less than a revolution in the economics and education of the country.

The work that has been carried on by Mr. Chatterton in Madras is, therefore, of peculiar interest and importance to Indian agriculture. During the last year, Mr. Chatterton's Department has made 209 borings, of which 66 tapped sub-artesian water supplies,—which means that the wells in which these borings were made cease to be merely reservoirs for the slow accumulation of water and become practically taps of a supply, to be obtained by pumping, limited chiefly by the size of the boring that can safely be made in each case. In 26 of these wells, permanent pumping installations have been erected, and there are now, in the Madras Presidency, over 300 pumping stations, of which 234 have been erected by the De-

partment, and 64 by private agency. It is estimated that the cost of lifting water by oil-engines is from a quarter to a half of that of doing so by bullock power.

In the Borsad Taluka of Gujarat, the Bombay Agricultural Department has found a region where a good supply of sub-artesian water can be tapped with fair certainty at a depth of about 100 feet below ground level. Eight boring plants were at work throughout the year, and large supplies of water were procured. Two district boards have bought sets of boring tools and 20 more have been bought by Government for dealing with the deficiency of water in Upper Gujarat. It is hoped that a very large proportion of this region may thus in the future be effectively protected against famine by means of wells.

In the Deccan, tests with the automatic water-finder have been continued. In no case has a favourable indication on the part of this instrument been found fallacious, but its practical value has still to be proved by further tests and a careful analysis of the results.

In Bengal, 34 borings were made during the year, but it has not been found possible to obtain a thoroughly trained superintendent for the work, and it is not considered that there is sufficient work to require the services of an expert engineer at present.

In the United Provinces, the demand for boring wells has fallen off slightly, owing to the good rainfall in recent years. Of the trial borings made 65 per cent. and of those in existing wells 69 per cent. were successful in obtaining water. An enquiry into the permanence of the improvement effected by boring has shown that unlined bore holes are apt to choke very quickly, but that if lined with piping there is every chance of the supply lasting for a long time. Enquiry regarding pumping plants was stimulated by the exhibition of water lifts at Allahábad. About 200 applications for advice regarding power plants were received, and 30 projects are believed to be in progress.

In the Punjab, boring operations have been begun, and 103 wells were bored in the year, in 70 of which an increased supply,

was obtained. The greatest success was met with in the Rohtak district, where 27 out of 33 borings were successful.

Progress in Government irrigation works in the older irrigated tracts of India hardly comes within the scope of this report. But, in the Central Provinces, the introduction of systematic irrigation on a large scale only began with the recommendations of the Irrigation Commission, the small area previously irrigated having been dependent on a precarious supply of water from wells and small tanks. Extension of irrigation in this province has therefore to go hand in hand with the education of the cultivators in the use of the water. Gratifying progress has been made in both these directions in the seven years that have elapsed since the report of the Commission was published. The average area irrigated in the three years 1907-10 was over 36,000 acres, and though the area in 1910-11 was 30 per cent. smaller owing to the excessive rainfall, the rates assessed exceeded Rs. 2 per acre as compared with less than Re. 1 per acre in 1908 and with an estimate made at the time of the Irrigation Commission's visit of from four to eight annas as the maximum that cultivators could be expected to pay. During the year, the Ramtek storage lake and the Asola Dam, estimated to irrigate 50,000 and 60,000 acres respectively, have been virtually completed. Smaller works have been in use for some years, but many of the minor water-courses remain to be completed by the ryots. Only one tank has yet irrigated the full area for which it was designed, and this has paid a return over and above the cost of maintenance and the interest on capital, although the water rates have not yet reached their final level.

The education of the cultivators in the use of water has been undertaken by the Agricultural Department, as far as the limited number of the trained staff permits, demonstrations being given in the method of transplanting rice and the growth of wheat, groundnut, and sugarcane, with irrigation. Increased yields of about seven maunds of late rice and over three maunds of wheat have been shown to result from irrigation. Experiments are also being made in the introduction of irrigated cold weather fodder crops which will supply an urgent want.

(*d*) *Alkali Lands.*—This subject was sufficiently dealt with in last year's report. Progress in investigations on the improvement of such land is necessarily slow. Bulletins on the salt lands of the Nira Valley by Dr. H. H. Mann and on "Kalar" in Sind by Mr. G. S. Henderson have been published by the Bombay Department of Agriculture during the year. Dr. Leather has continued his investigation of "Usar" land with special reference to its physical state. He has also in consultation with the Director of Agriculture and the Irrigation Department, United Provinces, carried out the first stage of a comprehensive experiment directed to determine definitely whether, as is frequently stated, irrigation leads, in certain lands, to an increase of alkali. In the Punjab, a preliminary survey of the constitution of the alkali soils of the province by Mr. Barnes, Principal of the Lyallpur College and Agricultural Chemist to the Punjab Government, has been concluded, and the results embodied in a report to the Director of Agriculture.

(*e*) *Dry-farming.*—The question of dry-farming has been very much before the agricultural public in recent years, an energetic propaganda having been started in America. The International Dry-farming Congress, whose head-quarters is at Colorado Springs, made strenuous efforts to obtain representatives from all parts of the world at their sixth meeting in October 1911, and in view of the importance to India of any development in the practices of surface cultivation and of implements designed for the purpose, the Inspector-General of Agriculture was, with the approval of the Government of India, appointed a Vice-President of the Congress, though unable to send any delegate to the meeting. Mr. William Macdonald's book on "Dry-farming, Its Principles and Practice" was reviewed in the January number of the Agricultural Journal of India for 1911 and the existence and importance of dry-farming in India was pointed out. Any improvements on the best methods already in use in India, will probably be bound up with the adoption of European or American methods and implements by land-holders and cultivators of comparatively large holdings,

or by co-operative societies. Trials of such implements are receiving detailed attention in most of the provinces of India and at Pusa, and any development that may result from the attention the subject is receiving, chiefly in America and also in Hungary where it has been energetically taken up by Monsieur de Miklos, Hungarian Secretary of State, will be closely followed.

(*f*) *Manures.*—The subject of fertilisers was dealt with very fully in last year's report for 1909-10. There has been no striking new departure in the year that has since elapsed, but, with the rise in prices of agricultural produce, which has so far been unaccompanied by any marked rise in the price of imported fertilisers, it is likely that they may soon become of greater importance in Indian agriculture. The results of the large number of experiments that have been carried on, or are now in progress, will enable advantage to be taken of the first opportunity afforded by any such change in economic conditions. The present tendency in such experiments in India is towards the application of smaller quantities of manure per acre than have been applied in the past, and to confine such experiments to valuable irrigated crops and to rice. It is clear that such a system is the right one so long as the relative prices of produce and fertilisers stand as they now do. Meanwhile perhaps the most hopeful line of progress is in the direction of green manuring, which is receiving attention in all the Provincial Departments, and at Pusa where Mr. Hutchinson is investigating the biological aspect. Good results from this practice have been obtained in Madras, and in Eastern Bengal, where the growth of green manuring crops with the assistance of phosphates is also being investigated and gives promising results. The value of phosphates, and of bonemeal in small quantities, for rice, on most soils, is becoming apparent in many parts of India. Good results from bonemeal have been obtained for a very long time at Burdwan in Bengal, and are now reported from Eastern Bengal and Assam, Raipur in the Central Provinces, and Coimbatore in Madras. In Madras superphosphate has also been found a generally profitable manure for paddy.

(*g*) *Sericulture.*—The Bengal Silk Committee consists of the Collector of Murshidabad and four representatives of the principal silk firms in Bengal, with the Director of Agriculture as President. At a special meeting of this Committee held in April 1911, which was attended by the Inspector-General of Agriculture, it was decided, on the recommendation of Mr. Lefroy, to give a trial to a system of hybridising European and Indian silk-worms, with the object of grafting on an Indian race the character of producing silk of the quality of that produced in China, Japan or Italy. A French expert will be engaged for the work, and the experiments will continue for three, and, if promising, for two further years. The system of small outlying nurseries is being abandoned : those built at Murshidabad, Ghatal and Midnapur will be converted into central nurseries under effective supervision, and the central nursery at Kalitha will be extended. It is hoped that the cost of the necessarily increased staff will be met out of income. Men will be trained at these central nurseries for disinfecting village rearing houses, without which the provision of disease-free "seed" would be useless.

There are now, at the nurseries, 19 rearing houses; 7 of these are at Berhampur where there is a plantation of 60 bighas of mulberries. The proceeds from the sale of "seed" have increased by one-third in the last two years, to nearly Rs. 8,000. The growing of Italian mulberries has been continued with great success, and it has been found that feeding the caterpillars, at the last stage, with leaves of this variety is a preventive of *grasserie.* The system of cold storage of seed cocoons continues to be successfully used for regulating the supply of seed according to the demand at different seasons.

In Eastern Bengal there are three rearing houses at the central station at Mirganj in the Rajshahi Division, and outlying stations at Baneswar and Kharkhari. Seed cocoons are sold at market prices, the object being to dispose of the nurseries as business enterprises as soon as a profit can be shown. These nurseries serve as demonstration centres of the advantages of good practice, being visited by purchasers of seed from other districts besides Rajshahi.

In the Punjab, seed continues to be distributed to growers by the Agricultural Department, but no great success appears to be achieved. The Department has issued a Bulletin on silk-worm rearing.

In Baroda experimental work with both mulberry and Eri silk-worms continues, but the extremes of heat and cold appear to make the conditions unsuitable for the extension of either industry.

At Pusa, experimental work has been continued on the rearing of European mulberry silk-worms and their crossing with the indigenous races.

The cultivation of Eri silk-worms is being continued at Pusa and has spread to nearly every district in India, Pusa acting as an agency for the distribution of samples and information, for technical training in the work, and for the supply of spinning machines.

Interest in this branch of the silk industry was stimulated by a very complete exhibit of methods and manufacture organised at the Allahabad Exhibition by the Pusa Entomological Section; every process from the egg to the finished cloth being shown at work. A gold medal was awarded to this exhibit.

Eri thread of fine count has been produced on a commercial scale by the Chhoi Silk Mill Company at Bombay, and the use of this fine thread should have an important influence on the development of the industry.

There is still some difficulty in the disposal of the small parcels, of cocoons and thread, produced by rearers on a small scale.

(*h*) *Poultry.*—Excellent progress has been made with the introduction of improved poultry in the Lushai Hills, owing largely to the personal interest taken in the matter by Colonel and Mrs. Cole. Over 5,000 eggs and 169 fowls were sold at high prices during the year, and it is estimated that there must now be 10,000 imported birds in the district. The pure Chittagong breed is best suited to the district, being the hardiest and the best layer. For the further extension of the work, it is proposed that selected villages in these hills should be regularly

inspected and indifferent birds weeded out, and that the district should be used as a centre for the distribution of the improved breeds in large numbers in other districts.

The central poultry breeding station for the plains districts of the Province is at Dacca, where China Langshans and Chittagongs are reared under the supervision of Mr. Meggitt, Agricultural Chemist to the Government, who is interested in poultry breeding. Experience has shown that breeds hatched as soon as possible after the end of the rains suffer much less from the rains in the following season than those hatched later.

In the United Provinces, the Haldwani farm has been maintained, and a considerable extension of the "utility" stock is contemplated. Very little success has been met with in other provinces where it is probable that it has not been found possible to devote to poultry the detailed attention on which success in this department depends.

In view of the absence of the demand from Provincial Departments, the number of breeds at Pusa has been reduced to two of the hardiest and best laying imported breeds and two promising indigenous breeds—Chittagongs, and a game breed from Lucknow, and work will be directed to the elucidation of the principles governing the successful production of eggs and table poultry in India, chiefly with a view to the maintenance, if possible, of the size and egg-laying capacity of improved breeds without having recourse to continual importation from abroad.

The imported ducks and geese have not proved successful, but, as there is a considerable demand for turkeys, the Mammoth Bronze breed which have on the whole done well, is being given a further trial.

(*i*) *Publications.*—During the year 1910-11, the Imperial Department of Agriculture issued seven bulletins and an equal number of Scientific Memoirs on different subjects. Six more Memoirs were in the press at the close of the year. The demand for the Scientific Memoirs, especially from the learned societies and institutions of foreign countries, is increasing as these

publications are becoming better known. Owing to the expansion of the work of the Department, more matter is now submitted for publication. The Provincial Departments are also supplying an increasing volume of contributions. The Agricultural Journal of India is gaining in popularity every year. Both Imperial and Provincial experts liberally help the Journal by their contributions. Acknowledgments are also due to other Government officials and private persons who have occasionally contributed to this periodical. The grant for publications was reduced from Rs. 25,000 to Rs. 23,000 during the year. A maximum limit for the edition of each publication having been prescribed, under government orders, the free distribution list was revised and considerably curtailed during the year.

Important practical conclusions, recommendations and suggestions were made in Bulletins Nos. 22, 23 and 24. Mr. and Mrs. Howard have shown in Bulletin No. 22, how, by careful cultivation and methods of conserving moisture, the superior wheats bred at Pusa can be made to give very high yields. Bulletin No. 23, the first edition of which has been exhausted, suggests a few simple and easily procurable remedies for common insect pests. Bulletin No. 24 describes an improved method of refining crude saltpetre devised by Dr. Leather. It gives more nitrate than the ordinary methods in use, the product is of higher quality, less fuel is required and the process is independent of the weather. Arrangements are now being made to test it on a commercial scale.

The Department of Agriculture, Bombay, published four bulletins and two leaflets during the year. Six more bulletins and five leaflets were in the press at the close of the year. One of these bulletins dealt with the long-stapled cotton in Sind and another with an examination of the seed supply of the Broach district, both subjects of very great economic importance.

In Madras, the Department of Agriculture published 12 leaflets in vernacular languages and communicated from time to time notes on subjects of interest to the English and vernacular press. The Agricultural Calendar, printed in all the langu-

ages of the Presidency, was issued in a more handy form this year and distributed to all village officers and elementary schools. It serves a very useful purpose in bringing the work of the Department to the notice of cultivators. The Department also arranged for the publication in English and vernacular languages of short summaries of the useful information contained in the reports of the Agricultural Stations.

In Bengal, the Quarterly Journal of Agriculture continued to be published by the Department. Special subjects are dealt with from time to time in the "Departmental Records." Six leaflets in English and vernacular languages were also issued and widely circulated.

A Year-book containing a summary of the departmental report, with articles of special interest, was published, in English and Bengali, by the Department of Agriculture of Eastern Bengal and Assam. A leaflet containing hints on the cultivation of the fig tree was also published during the year. Mr. Meggitt, in collaboration with Dr. Mann, has brought out a Memoir on the composition of the milk of some breeds of Indian cows and buffaloes, and its variations.

In the United Provinces, the Department published three bulletins in English and also three pamphlets in vernacular, and continued to patronise the vernacular journals. The Proceedings of the Agricultural Conference at Allahabad have also been issued in book form. Mr. Clarke, the Agricultural Chemist, in conjunction with Mr. S. C. Banerji, has published a paper, on a Glucoside from *Tephrosia purpurea*, in the Transactions of the Chemical Society of London. The results of Mr. Leake's investigations on Indian and Exotic Cottons are now being published. Mr. Burt, the Deputy Director of Agriculture, contributed to the July (1911) issue of the Agricultural Journal of India an interesting article on the Sugar Factory exhibited at Allahabad.

The Department of Agriculture, Punjab, issued a bulletin on silk-worm rearing in the Punjab, and also two leaflets, one on bee-keeping, and the other giving brief instructions for rearers of silk-worms.

In the Central Provinces, the Agricultural Gazette continued to be issued in Hindí, English, and Marathi, the circulation showing a slight increase in the case of the Marathi edition. The Department also published during the year a bulletin (No. 4) by Mr. Evans, Deputy Director of Agriculture, Northern Circle, on the quality of wheat exported from the Central Provinces. Contributions were also made to the press on various important features of the work of the Department.

Three bulletins and four leaflets were published by the Department of Agriculture, Burma. A publication on the Agricultural Survey of the Sagaing district has also been completed. Mr. Warth, the Agricultural Chemist, published during the year a preliminary report on the Classification of Paddies grown in Upper Burma.

A complete list of the publications of the Imperial and Provincial Departments during the year is given as an appendix to this report.

(*j*) *Expenditure.*—The expenditure incurred by the Imperial Department of Agriculture during 1910-11, amounted to Rs. 4,40,422 as detailed below :—

		Rs.
Inspector-General of Agriculture		1,19,020
Imperial Cotton Specialist		21,816
Agricultural Research Institute, Pusa		2,99,586
	Rs.	
Office of the Director	64,176	
Chemical Section	39,729	
Mycological Section	21,170	
Entomological Section	54,707	
Second Entomological Section	8,245	
Botanical Section	37,566	
Bacteriological Section	18,893	
Agricultural Section	55,100	
	2,99,586	
TOTAL		4,40,422

The amount of Rs. 4,40,422, shown above, includes expenditure under special grants placed at the disposal of the Inspector-General of Agriculture. The principal items of expenditure under these special grants are as follows :—

	Rs.	Rs.
(1) Grants-in-aid of the Indian Tea Association		15,000
(2) Grants-in-aid of the Department of Agriculture, Bombay :—		
(*i*) for experiments in deep ploughing	1,350	
(*ii*) for experiments with Mansfield's automatic water-finder	767	
(*iii*) contribution to the Surat Farm	525	
		2,642
(3) Grants-in-aid of the Department of Agriculture, Bengal, for purchasing a hand power centrifugal		550
(4) Paid to the Behar Planters' Association towards the pay of the Flax Expert		2,750
(5) Paid to the Imperial Cotton Specialist for museum collections, etc		907
(6) Poultry breeding experiments at Pusa		4,042
(7) Purchase of cows and goats for breeding experiments at Pusa		2,493
(8) Experiments in milling and baking qualities of Indian wheats		816
(9) Purchase of seeds		364
		29,564

The expenditure incurred by the Provincial Departments of Agriculture during the year under report is Rs. 27,04,955 as shown below :—

	Rs.
Bengal	3,31,488
United Provinces	4,23,200

Punjab	2,97,152*
Bombay	6,98,370†
Madras	3,27,611
Central Provinces	2,21,605
Burma	1,28,389
Eastern Bengal and Assam	2,77,140
TOTAL	27,04,955

Thus the total expenditure incurred both by the Imperial and Provincial Departments of Agriculture amounted during the year under report to about 31½ lakhs.

* This includes Rs. 70,618 spent on public works.
† This includes Rs. 1,14,924 spent on account of the Agricultural College building.

APPENDIX.

List of Agricultural Publications in India during 1910-11.

No.	Title.	Author.	Where published.
	General Agriculture.		
1	Report on the Progress of Agriculture in India, 1909-10. Price 6 annas or 7*d.*	Inspector General of Agriculture in India.	Government Printing, India, Calcutta.
2	Report of the Agricultural Research Institute and College, Pusa (including report of the Imperial Cotton Specialist, 1909-10). Price 4 annas or 5*d.*	Ditto .	Ditto.
3	Agricultural Journal of India, Vol. V, Parts 3 and 4, and Vol. VI, Parts 1 and 2. Annual subscription Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
4	Memorandum on Indian Wheat for the British Market, Bulletin No. 20 of the Agricultural Research Institute, Pusa. Price 4 annas or 6*d.*	Sir James Wilson, K.C.S.I.	Government Printing, India, Calcutta.
5	Memorandum regarding leading Eucalypts suitable for India, Bulletin No. 21 of the Agricultural Research Institute, Pusa. Price 4 annas or 5*d.*	F. Booth Tucker .	Ditto.
6	Report on the Flax Experiments conducted at Dooriah during the year 1910-11. Bulletin No. 25 of the Agricultural Research Institute, Pusa. Price 6 annas or 7*d.*	E. M. Vandekerkhove, Flax Expert to the Behar Indigo Planters' Association.	Ditto.
7	Note on the Present Position of Cotton Investigation in India, Bulletin No. 26. Price 2 annas or 3*d.*	B. Coventry, Officiating Inspector General of Agriculture in India.	Ditto.
8	Annual Report of the Board of Scientific Advice for the year 1909-10. Price Re. 1.	Board of Scientific Advice for India.	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
9	Prices and Wages in India, 27th issue 1910. Price Rs. 2 or 3*s.*	Compiled in the Office of Director General of Commercial Intelligence.	Government Printing. India, Calcutta.
10	Area and Yield of certain Principal Crops in India for various periods from 1895-96 to 1909-10. Price 4 annas.	Commercial Intelligence Department of the Government of India.	Ditto.
11	Area and Yield of certain Principal Crops in India for various periods from 1896-97 to 1910-11. Price 4 annas or 6*d.*	Commercial Intelligence Department, Government of India.	Ditto.
12	Agricultural Statistics of India for the years 1904-05 to 1908-09, Vol. I. Price 2 annas.	Compiled in the Office of the Director General of Commercial Intelligence.	Ditto.
13	Notes on Sugar in India. Price Rs. 1-12-0 or 2*s.* 6*d.*	Fred. Noël-Paton, Director General of Commercial Intelligence.	Ditto.
14	*Oryza sativa*—Literature on the Races of Rice in India. Agricultural Ledger No. 1 of 1910. First half A-K. Price 12 annas or 1*s.* 2*d.*	Compiled in the Office of the Reporter on Economic Products to the Government of India.	Ditto.
15	*Oryza sativa*—Literature on the Races of Rice in India. Agricultural Ledger No. 1 of 1910. Second half L-Z. Price 10 annas or 1*s.*	Ditto	Ditto.
16	Guano and Edible Frogs. Agricultural Ledger Nos. 1 & 2 of 1911. Price 1 anna or 1*d.*	I. H. Burkill, M.A.	Ditto.
17	*Glycine hispida*; the Soy bean in India. Agricultural Ledger No. 3 of 1911. Price 2 annas or 2*d.*	David Hooper	Ditto.
18	Report of Flax Work at Dooriah Factory for the year 1909-10.	E. M. Vandekerhove, Flax Expert to the Behar Planters' Association.	Ross & Co.'s Press, Muzafferpur.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
19	Annual Report of the Department of Agriculture, Bombay, for 1909-10. Price 8 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
20	Season and Crop Report of the Bombay Presidency for 1909-10. Price 7 annas or 8*d*.	Ditto .	Ditto.
21	Annual Report on the Experimental work of the Surat Agricultural Station for 1909-10. Price 14 annas.	Ditto .	Ditto.
22	Annual Report on the Experimental work of the Dharwar Agricultural Station for 1909-10. Price 4 annas.	Ditto .	Ditto.
23	Annual Report on the Experimental work of the Dhulia Agricultural Station for 1909-10. Price 10 annas.	Ditto .	Ditto.
24	Annual Report on the Experimental work of the Nadiad Agricultural Station for 1909-10. Price 10 annas.	Ditto .	Ditto.
25	Annual Report on the Experimental work of the Dohad Agricultural Station for 1909-10. Price 10 annas.	Ditto .	Ditto.
26	Annual Report on the Experimental work of the Gokak Canal Agricultural Station for 1909-10. Price As. 8.	Ditto .	Ditto.
27	Annual Report on the Experimental work of the Mirpurkhas Agricultural Station for 1909-10. Price 7 annas.	Ditto .	Ditto.
28	Annual Report on the Experimental work of the Daulatpur Reclamation Station for 1909-10. Price 10 annas.	Ditto .	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
29	Annual Report on the Experimental work of the Manjri Agricultural Station for 1909-10. Price 4 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
30	Annual Report on the Experimental work of the Lonavla Agricultural Station for 1909-10. Price 4 annas.	Ditto	Ditto.
31	Annual Report on the Kirkee Civil Dairy for 1909-10. Price 4 annas.	Ditto	Ditto.
32	Annual Report on the work of the Agricultural College Station for 1909-10. Price 8 annas.	Ditto	Ditto.
33	Annual Report on the Experimental work of the Ganeshkhind Botanical Station for 1909-10. Price 5 annas.	Ditto	Ditto.
34	Annual Report on the Experimental work of the Bassein Botanical and Agricultural Station for 1909-10. Price 5 annas.	Ditto	Ditto.
35	The Cultivation of Guavas near Poona, Dharwar and Limbgaon. Bulletin No. 40 of 1911. Price 12 annas or 1*s.* 2*d.*	L. B. Kulkarni, L.Ag., Probationer under the Economic Botanist, Bombay.	Ditto.
36	Groundnuts in the Bombay Deccan. Bulletin No. 41 of 1911. Price 4 annas or 5*d.*	R. S. G. K. Kelkar, Assistant Professor, Agricultural College, Poona.	Ditto.
37	Note on Long-stapled cotton in Sind. Bulletin No. 42 of 1911. Price 3 annas or 3*d.*	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture, Sind.	Ditto.
38	An Examination of the seed supply of the Broach District, Part II. Bulletin No. 43 of 1911. Price 5 annas or 6*d.*	G. D. Mehta, L.Ag., B.A., N.D.A., N.D.D.	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
39	Note on Improved and Exotic Cottons in the Bombay Presidency.	G. F. Keatinge, I.C.S.	
40	Cultivation of Broach Cotton in Dharwar. Translation in Canarese of Bulletin No. 33. Price annas 4.	M. L. Kulkarni, Divisional Inspector, S.D., Bombay Presidency.	Government Central Press, Bombay.
41	Guinea-worm. Leaflet No. 6 of 1910	Department of Agriculture in Bombay.	Ditto.
42	Manuring with Tag or Sann-hemp. Leaflet No. 2 of 1911.	Ditto .	Ditto.
43	Report on the Operations of the Agricultural and Civil Veterinary Department, Madras, for the official year 1909-10. Price annas 6.	Department of Agriculture, Madras.	Government Press, Madras.
44	Scientific Report of the Agricultural Station, Coimbatore. Price 4 annas or 6*d.*	R. Cecil Wood, B.A. .	Ditto.
45	Scientific Report of the Agricultural Station, Bellary. Price 2 annas or 3*d.*	G. R. Hilson, B.SC., and R. W. B. C. Wood, B.A.	Ditto.
46	Scientific Report of the Agricultural Station, Nandyal. Price 2 annas or 3*d.*	Ditto .	Ditto.
47	Scientific Report of the Agricultural Station, Hagari, for 1909-10. Price annas 2 or 3*d.*	Ditto .	Ditto.
48	Scientific Report of the Agricultural Station, Samalkota, for 1909-10. Price annas 3 or 4*d.*	Ditto .	Ditto.
49	Scientific Report of the Agricultural Station, Taliparamba, for 1909-10. Price 2 annas or 3*d.*	H. C. Sampson, B.SC.	Ditto.
50	Scientific Report of the Agricultural Station, Koilpatti, for 1909-10. Price 2 annas or 3*d.*	Ditto .	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
51	Scientific Report of the Agricultural Station, Palur, for 1909-10. Price 2 annas or 3*d*.	H. C. Sampson, B.SC.	Government Press, Madras.
52	The Home Farm Sivagiri Estate, Tinnevelly, Madras, Bulletin No. 62, Vol. III. Price 6 annas or 6*d*.	J. M. Lonsdale, N.D.A., N.D.D., Agricultural Expert, Court of Wards, assisted by A. Rama Rao Avergal.	Ditto.
53	The Conservation of Cattle Urine. Leaflet in English, Tamil and Malayalum.	H. C. Sampson, B.SC.	Ditto.
54	Experiences of single seedling planting. Leaflet in English, Tamil and Telugu.	Kolandavelu Udayar	Ditto.
55	Useful facts learnt from the Experimental Cultivation at Talipa-ramba. Leaflet in Canarese and Malayalum.	H. C. Sampson, B.SC.	Ditto.
56	Useful facts learnt from the Experimental Cultivation at Palur. Leaflet in English and Tamil.	Ditto	Ditto.
57	Light Traps. Leaflet in English.	C. A. Barber, SC.D., F.L.S.	Ditto.
58	Individual Manuring of Paddy. Leaflet in English and Tamil.	H. C. Sampson, B.SC.	Ditto.
59	Practical Lessons drawn from Experiments at the Central Farm, Coimbatore. Leaflet in Tamil, Malayalum, Telugu and Canarese.	R. W. B. C. Wood, B.A.	Ditto.
60	Useful facts learnt at Koilpatti. Leaflet in Tamil.	H. C. Sampson, B.SC.	Ditto.
61	Note on Sugarcane Cultivation on the Western Coast. Leaflet No. 2 in Malayalum.	Umikrishna Menon	Ditto.
62	A Dialogue on Single Planting of Paddy. Leaflet No. 3 in Tamil.	Kolandamlu Udayar	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
63	A Note on Wild Indigo. Leaflet No. 4 in Tamil and Telugu.	A. Rama Rao, Home Farm Superintendent, Sivagiri.	Government Press, Madras.
64	Improvements in Ryots' Lands. Leaflet No. 6 in Telugu and Uriya.	G. R. Hilson, B.SC. .	Ditto.
65	Advantages of using Iron Ploughs in Black Cotton Soils. Leaflet No. 7 in Telugu.	Ditto .	Ditto.
66	Manuring in the Kistna. Leaflet No. 9 in Telugu.	Ditto .	Ditto.
67	Dhaincha—Sesbanea Aculeata—New Green Manure Crops. Leaflet No. 10 in English, Tamil and Telugu.	H. C. Sampson, B.SC.	Ditto.
68	Cambodia Cotton. Leaflet No. 11 in Canarese.	G. R. Hilson, B.SC. .	Ditto.
69	Reprint of Single Planting of Paddy and Green Manuring, in Tamil.	H. C. Sampson, B.SC., and C. Narayan Iyer.	Ditto.
70	Lists (5) of seeds available for sale in Northern Division, in Telugu.	G. R. Hilson, B.SC. .	Ditto.
71	Note on Sugarcane Cultivation. Leaflet No. 13 in English.	M. Govinda Kidaore	Ditto.
72	Hints to Owners of Ginning Factories. Leaflet No. 16 in English.	M. E. Couchman, I.C.S.	Ditto.
73	Annual Report of the Department of Agriculture, Bengal, for the year ending 30th June 1910. Price 8 annas.	Department of Agriculture, Bengal.	Bengal Secretariat Book Depot, Calcutta.
74	Annual Report of the Agricultural Stations in charge of the Deputy Director of Agriculture, Bengal, for the year 1909-10. Price 4 annas.	F. Smith, B.SC., F.H.A.S.	Ditto.
75	Annual Report of the Kalimpong Demonstration Farm for the year 1909-10. Price 8 annas.	P. W. Goodwin .	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
76	Note on Agricultural Shows with recommendations for future Exhibitions. Departmental Record No. 1 of 1909. (Not for sale.)	E. J. Woodhouse, B.A.	Bengal Secretariat Book Depot, Calcutta.
77	Some suggestions as to the Organisation of Agricultural Exhibitions in Bengal. Departmental Record No. 1 of 1910. (Not for sale.)	Ditto .	Ditto.
78	Recommendations for the work of the Department in assisting the Agricultural Shows of Bengal. Departmental Records No. 2 of 1910. (Not for sale.)	Ditto .	Ditto.
79	Quarterly Journal of the Department of Agriculture, Bengal, Vol. IV, Nos. 1 to 4. Price 6 annas per copy.	Department of Agriculture, Bengal.	Ditto.
80	Agricultural Statistics of Bengal for 1909-10. Price Rs. 1-4-0 or 1*s.* 9*d.*	Ditto .	Ditto.
81	Season and Crop Report of Bengal for 1909-10. Price 6 annas or 6*d.*	Ditto .	Ditto.
82	Annual Report of the Department of Agriculture, Eastern Bengal and Assam, for the year ending 30th June 1910.	Department of Agriculture, Eastern Bengal and Assam.	Government Secretariat Press, Eastern Bengal and Assam, Shillong.
83	Annual Report of the Dacca Agricultural Station for the year ending 30th June 1910. Price 2 annas.	Ditto .	Ditto.
84	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1910. Price 2 annas.	Ditto .	Ditto.
85	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1910. Price 2 annas.	Ditto .	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
86	Annual Report of the Burirhat Agricultural Station for the year ending 30th June 1910. Price 2 annas.	Department of Agriculture, Eastern Bengal and Assam.	Government Secretariat Press, Eastern Bengal and Assam, Shillong.
87	Annual Report of the Shillong Fruit Garden for the year ending 30th June 1910. Price 2 annas.	Ditto .	Ditto.
88	Annual Report on the Tropical Plantation at Wahjain, for the year ending 30th June 1910. Price 2 annas.	Ditto .	Ditto.
89	Annual Report of the Agricultural Stations in Eastern Bengal and Assam for the year 1909-10. Price 12 annas.	Ditto .	Ditto.
90	Year Book of the Agricultural Department of Eastern Bengal and Assam, 1318 B. S. Price 2 annas.	Ditto .	Ditto.
91	Krishi Samachar of the Agricultural Department of Eastern Bengal and Assam, 1318 B. S. (In Bengali.) Price 2 annas.	Ditto .	Ditto.
92	Central Seed Depot, Dacca. Leaflet No. 2 of 1910.	Ditto .	Ditto.
93	Hints on the Cultivation of the Fig tree. Leaflet No. 4 of 1910.	Ditto .	Ditto.
94	A Circular letter to Cultivators in the Khasi hills (Khasi and English).	Ditto .	Government Press, Shillong.
95	Rules for supply of seeds, manures and implements at reduced rates to Honorary Correspondents and Associates of the Department of Agriculture, Eastern Bengal and Assam.	Ditto .	Ditto.
96	Report on the Season and Crops of Eastern Bengal and Assam for the year ending 31st March 1910. Price 9 annas or 9*d*.	Ditto .	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
97	Report on Tea Culture in Eastern Bengal and Assam for the year 1909. Price 8 annas or 9*d*.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Printing Office, Shillong.
98	Report on the administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1910. Price 8 annas.	Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
99	Annual Report of the Aligarh Agricultural Station for the year ending 30th June 1910. Price 8 annas or 9*d*.	Ditto .	Ditto.
100	Annual Report of the Partabgarh Agricultural Station for the year ending 30th June 1910. Price 8 annas or 9*d*.	Ditto .	Ditto.
101	Annual Report of the Cawnpore Agricultural Station for 1909-10 and 1910-11. Price Re. 1 or 1*s*. 6*d*.	Ditto .	Ditto.
102	Annual Report of the Jalaun (Orai) Agricultural Station for the years 1909-10 and 1910-11. Price 8 annas or 9*d*.	Ditto .	Ditto.
103	Notes on the Cultivation of Lucerne. Bulletin No. 6 (revised).	Ditto .	Ditto.
104	Note on the Foot and Mouth Disease of Cattle in the United Provinces. Bulletin No. 24.	E. W. Oliver, M.R.C.V.S., F.Z.S., Superintendent, Civil Veterinary Department, United Provinces.	Ditto.
105	Notes on Improvement of Cattle in the United Provinces. Bulletin No. 25. Price 6 pies.	W. H. Moreland, C.I.E., I.C.S., and E. W. Oliver, M.R.C.V.S., F.Z.S.	Ditto.
106	Proceedings of the Agricultural Conference held at the United Provinces Exhibition, Allahabad, in January 1911.	Department of Agriculture, United Provinces.	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
107	Pamphlet on Ensilage in Urdu and Hindi.	A. E. Parr, PH.D., B.SC.	Newal Kishore Press, Lucknow.
108	Pamphlet on the Potato Moth in Urdu and Hindi.	Department of Agriculture, United Provinces.	Ditto.
109	Pamphlet on Sugarcane Grasshopper. In Urdu and Hindi.	Ditto .	Ditto.
110	Season and Crop Report of the United Provinces for 1909-10. Price 8 annas or 9*d*.	Ditto .	Government Press, Allahabad.
111	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1910. Price 3 annas.	Department of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
112	Annual Report of the Lyallpur Agricultural Station for 1909-10. Price 13 annas 6 pies or 1*s*. 4*d*.	Ditto .	Ditto.
113	Cattle and Dairying in the Punjab	Ditto .	Ditto.
114	Report on the Season and Crops of the Punjab for 1909-10. Price 9 annas or 1*s*.	Ditto .	Ditto.
115	Report on the working of the Department of Agriculture, Central Provinces, for the year 1909-10. Price Re. 1.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
116	Report on the Agricultural Stations in the Central Provinces and Berar for the year 1909-10. Price Re. 1.	Ditto .	Ditto.
117	The Improvement in the quality of Wheat exported from the Central Provinces. Bulletin No. 4. Price Re. 1.	G. Evans, B.A., Deputy Director of Agriculture, Northern Circle.	Ditto.
118	Note on Cattle Survey in the Central Provinces. (Price not fixed.)	Department of Agriculture, Central Provinces.	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
119	Agricultural Gazette. A monthly publication. Price 2 annas per copy.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
120	Season and Crop Report of the Central Provinces for the year 1909-10. Price 8 annas or 9*d*.	Ditto	Ditto.
121	Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June 1910. Price 6 annas.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
122	Scientific Report of the Mandalay Agricultural Station for the year 1909-10.	Ditto	Ditto.
123	Season and Crop Report of Burma for the year ending 30th June 1910. Price 8 annas or 9*d*.	Ditto	Ditto.
124	Papers on the Manufacture of Jaggery from the juice of the Toddy Palm with special reference to the effects of the Industry on the Timber supply of the Dry Zone of Burma. Bulletin No. 3 of 1910. Price 2 annas.	Ditto	Ditto.
125	Notes on tree cotton cultivation in Burma. Bulletin No. 5. Price 2 annas or 2*d*.	E. Thompstone, B.SC., Deputy Director of Agriculture, Burma.	Ditto.
126	Agricultural Surveys, No. 2 Sagaing District.	A. McKerral, M.A., B.SC., Deputy Director of Agriculture, Burma.	Ditto.
127	The Mandalay Experiment Station. Cultivator's Leaflet No. 20.	J. MacKenna, I.C.S.	Ditto.
128	Annual Report of the Department of Agriculture, Baroda State, for 1910. Price 4 annas.	Department of Agriculture, Baroda.	Baroda Printing Works.
129	Report on the work done on the Rangpur Farm. Price 2 annas.	....	R. P. W. Company, 154, Upper Chitpur Road, Calcutta.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
130	Profits from levelling and Bunding land (a book in Marathi).	Mahadeo Narayan Deodhar, Baramati.	
131	Heeleaka Experiment Station Final Report, including investigations during 1909.	G. D. Hope, PH.D., and P. H. Carpenter, F.I.C., F.C.S.	Indian Tea Association, Calcutta.
132	Note on the Culivation of Tea Soils.	G. D. Hope, PH.D. .	Ditto.
133	Quarterly Journal, Parts 1 and 2 .	The Indian Tea Association, Scientific Department.	Catholic Orphan Press, Calcutta.
134	The Planters' Chronicle, a weekly edition.	United Planters' Association of Southern India.	Bangalore Daily Post, Ltd., Press.
	Agricultural Chemistry.		
135	The Indian Saltpetre Industry, Bulletin No. 24 of the Agricultural Research Institute, Pusa. Price 8 annas or 9*d*.	J. W. Leather, PH.D., F.I.C., F.C.S., Imperial Agricultural Chemist, and Jatindra Nath Mukherji, B.A., B.SC., Second Assistant to the Imperial Agricultural Chemist.	Government Printing, India, Calcutta.
136	Water requirements of crops in India. II. Memoirs of the Imperial Department of Agriculture, Chemical Series, Vol. I, No. 10. Price Rs. 2-8-0.	J. W. Leather, PH.D., F.I.C., F.C.S.	Messrs. Thacker, Spink & Co., Calcutta.
137	The Composition of the Milk of some breeds of Indian cows and buffaloes and its variations, Part I. Memoirs of the Imperial Department of Agriculture, Chemical Series, Vol. II, No. 1. Price Rs. 1-8-0.	A. A. Meggitt, B.SC., Agricultural Chemist to the Government of Eastern Bengal and Assam, and H. H. Mann, D.SC., Agricultural Chemist to the Government of Bombay.	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	Agricultural Chemist y—concld.		
138	Notes on classification and examination of the canes at present indigenous to Bengal. Departmental Record No. 3 of 1910.	C. S. Taylor, B.A., Agricultural Chemist to the Government of Bengal.	Bengal Secretariat Press, Calcutta.
139	The salt lands of the Nira Valley. Bulletin No. 39 of 1910 of the Department of Agriculture, Bombay. Price 5 annas.	Harold H. Mann, D.SC., and V. A. Tamhane, L.Ag.	Government Central Press, Bombay.
140	The Composition of Indian rice. The Agricultural Ledger No. 5 of 1908-09. Price 4 annas.	David Hooper, F.C.S.	Government Printing, India, Calcutta.
141	Manufacture of *Gur*. Leaflet No. 5 of 1910 of the Department of Agriculture, Bengal.	C. S. Taylor, B.A., and N. C. Chowdhurry.	Bengal Secretariat Press, Calcutta.
142	Use of Shallow Pan for *Gur* making. Leaflet No. 6 of 1910 of the Department of Agriculture, Bengal.	N. C. Chowdhurry .	Ditto.
143	The Preservation of Farmyard manure Leaflet No. XIV, in English, Tamil and Telugu.	W. H. Harrison, M.SC., Agricultural Chemist to the Government of Madras.	Government Press, Madras.
	Mycology.		
144	First Experiments in the Treatment of Grape-vine Mildew in the Bombay Presidency. Bulletin No. 36 of 1910 of the Department of Agriculture, Bombay. Price 14 annas.	W. Burns, B.SC. .	Government Central Press, Bombay.
145	The Ring Disease of potatoes. Bulletin No. 1 of the Mysore Department of Agriculture.	L. C. Coleman, M.A., PH.D.	Mysore Government Press, Bangalore.
146	Diseases of the Areca Palm, 1 Koleroga. Price Rs. 2.	Ditto .	Ditto.
147	Instructions for sending plants attacked with parasitic fungi. Leaflet No. 1.	W. McRae, M.A., B.SC., Mycologist to the Government of Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	Mycology—contd.		
148	Note on the Potato crop. Leaflet No. 12.	W. McRae, M.A., B.SC., and G. R. Hilson, B.SC.	Government Press, Madras.
149	Bud-rot in Godaveri and Kistna Districts. Leaflet No. 15 in Telugu.	W. McRae, M.A., B.SC.	Ditto.
150	The Treatment of Grapevine Mildew. Leaflet No. 1.	Bombay Department of Agriculture.	Government Central Press, Bombay.
	Economic Botany.		
151	Millets of the Genus Setaria in the Bombay Presidency and Sind. Memoirs of the Imperial Department of Agriculture, Botanical Series, Vol. IV, No. 1. Price Re. 1.	G. A. Gammie, F.L.S.	Messrs. Thacker, Spink & Co., Calcutta.
152	The Milling and Baking qualities of Indian Wheats No. 3. Bulletin No. 22 of the Agricultural Research Institute, Pusa. Price 7 annas or 8 pence.	A. Howard, M.A., A.R.,C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist, Associate and Late Fellow of Newnham College, Cambridge.	Government Printing, India, Calcutta.
153	A preliminary note on the classification of paddies grown in Upper Burma. Occasional Papers, No. 1.	E. Thompstone, B.SC., and A. M. Sawyer.	Government Printing, Burma, Rangoon.
154	Bambuchu and how to contact it. Leaflet No. 5 in English and Canarese.	C. A. Barber, SC.D., M.A., F.L.S.	Government Press, Madras.
155	A Note on Coconut Beetles. Leaflet No. 8 in English, Malayalam, Canarese, Tamil and Telugu.	Ditto	Ditto.

List of Agricultural Publications in India during 1910-11—contd.

No.	Title.	Author.	Where published.
	Economic Botany—contd.		
156	Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan Tracts, Vol. II. Price Rs. 2 or 3*s*.	J. F. Duthie, B.A., F.L.S., formerly Director of the Botanical Department of Northern India.	Government Printing, India, Ca'cutta.
	Entomology.		
157	Insecticides—Mixtures and Recipes for use against Insects in the Field, the Orchard, the Garden and the House. Bulletin No. 23 of the Agricultural Research Institute, Pusa. Price 12 annas or 1*s*. 2*d*.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
158	The Rice Grasshopper (*Hieroglyphus banian, Fabr.*). Bulletin No. 1 of the Mysore Department of Agriculture. Price Re. 1.	L. C. Coleman, M.A., PH.D., Mycologist and Entomologist to the Government of Mysore.	Government Press, Bangalore.
159	The Jola or Deccan Grasshopper (*Colemania Sphenarioides Bol.*). Bulletin No. 2 of the Department of Agriculture, Mysore. Price Re. 1.	Ditto	Ditto.
160	Fasaler Poka. Text-book. (Bengali.)	C. C. Ghosh, B.A.	Indian Gardening Association, 162, Bowbazar Street, Calcutta.
161	Practical Hints on Bee-keeping in Simla. Bulletin No. 2 of 1910.	Department of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
162	Notes on the Silk-worm Rearing in the Punjab. Bulletin No. 3 of 1910.	Ditto	Ditto.
163	A leaflet on brief instructions for rearers of silk-worms.	Department of Agriculture, Punjab.	Civil and Military Gazette Press, Lahore.
164	Instructions for Rearing Eri-silk Worms. Leaflet in English, Hindi and Bengali.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S.	Government Printing, India, Calcutta.
165	Eri seed Exchange . . .	Ditto	Ditto.

List of Agricultural Publications in India during 1910-11—concld.

No.	Title.	Author.	Where published.
	Entomology—contd.		
166	The Rice Hispa. Leaflet No. 1 of 1910 of the Department of Agriture, Bengal.	H. L. Dutt . .	Bengal Secretariat Press, Calcutta.
167	The Rice Fulgorid. Leaflet No. 2 of 1910 of the Department of Agriculture, Bengal.	Ditto . .	Ditto.
168	Sugarcane Borer. Leaflet No. 3 of 1910 of the Department of Agriculture, Bengal.	Ditto . .	Ditto.
169	Pests of Pulses. Leaflet No. 4 of 1910 of the Department of Agriculture, Bengal.	Ditto . .	Ditto.
170	The Rhinoceros Bettle (*Oryctes Rhinoceros, Linn.*) and its ravages in Burma. Bulletin No. 4 of 1910.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
171	The Rice Hispa. Cultivator's Leaflet No. 24 of 1910 of the Department of Agriculture, Burma.	Ditto .	Ditto.
172	The Swarming Paddy Caterpillar. Cultivator's Leaflet No. 25.	Ditto .	Ditto.
173	The Lemon Butterfly. Cultivavator's Leaflet No. 27.	Ditto .	Ditto.
174	Some common Insect Pests which attack food-grains. Leaflet No. 3 of 1910, in English, Bengali and Assamese.	Department of Agriculture, Eastern Bengal and Assam.	Government Press, Eastern Bengal and Assam, Shillong.

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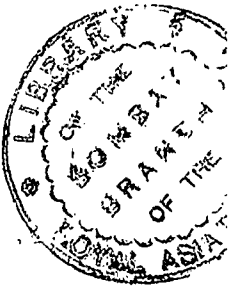
REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1911-12



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Royal Asiatic Society.

TABLE OF CONTENTS.

	PAGE.
Introductory	1
Cotton	1
Wheat	2
Sugarcane	2
Groundnut	3
Fruit Experiments	4
Palm-Sugar	4
Veterinary Pathology	4
Economic Development	5
Part I.—Development of the Work of the Imperial Department of Agriculture.	9
1. Office of the Agricultural Adviser to the Government of India.	9
2. Tours	9
3. Agricultural Research Institute, Pusa	10
(*a*) Administration	10
(*b*) Training	10
(*c*) Agriculture	11
(*d*) Chemistry	11
(*e*) Botany	11
(*f*) Mycology	12
(*g*) Entomology	12
(*h*) Pathological Entomology	13
(*i*) Agricultural Bacteriology	13
Part II.—Progress in the Provinces	14
1. Bombay	14
2. Madras	14
3. Mysore	15
4. Central Provinces	16
5. Bengal	17
6. Bihar and Orissa	18
7. Assam	19
8. United Provinces	19
9. Punjab	20
10. Burma	22

PAGE.

Part II.—Progress in the Provinces—*contd.*

11. North-West Frontier Province 23
12. Baroda 23

Part III.—Progress in Veterinary Work 23

1. Veterinary Pathology 23
2. Breeding Operations 26
3. Cattle Survey 26

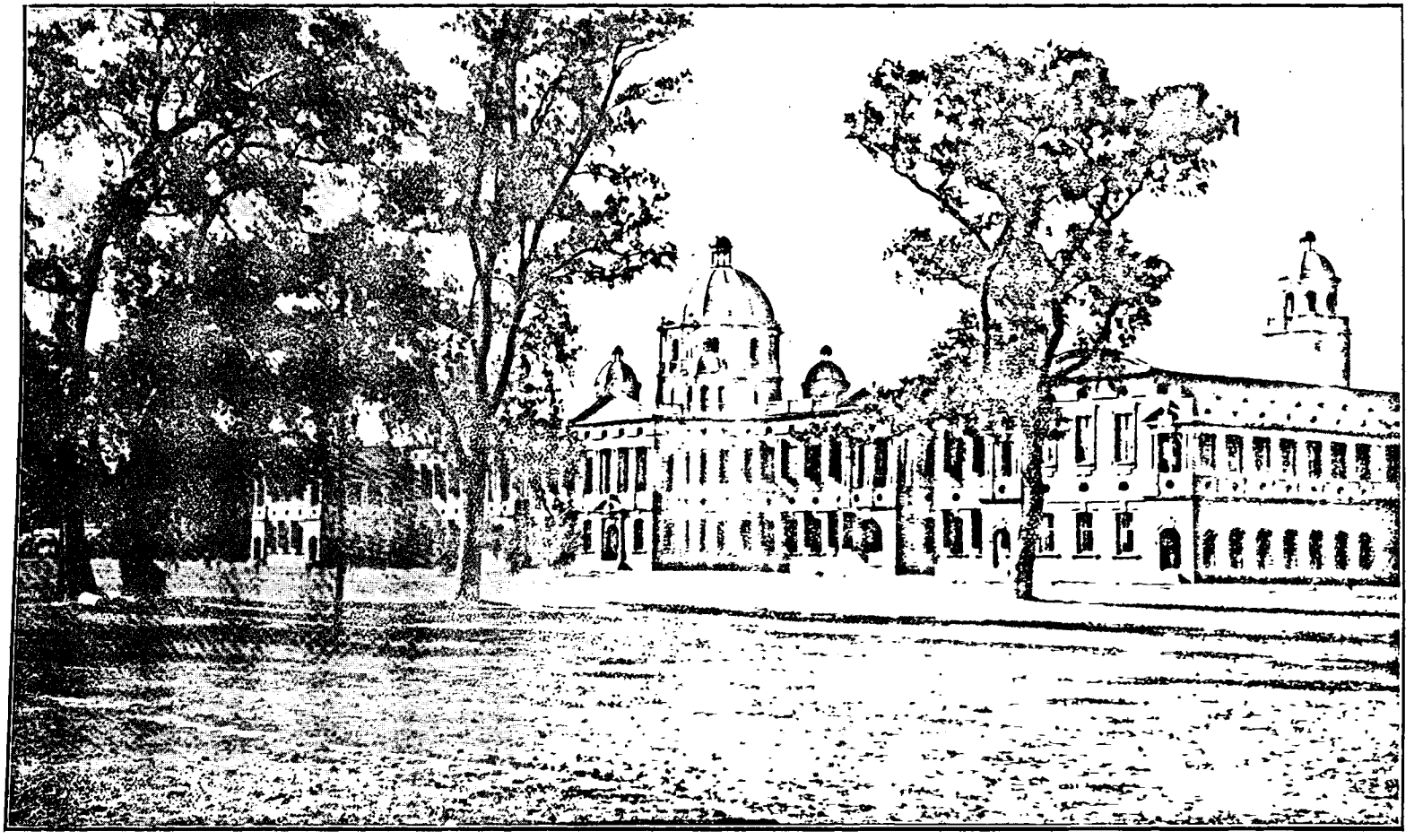
Part IV.—Crops and Special Subjects 27

1. Crops 27
   (*a*) Cotton 27
   (*b*) Wheat 30
   (*c*) Sugarcane 33
   (*d*) Tobacco 34
   (*e*) Oil-seeds 35
   (*f*) Fibre Crops 37
   (*g*) Rice 37
   (*h*) Tea, Coffee and Rubber 38
   (*i*) Indigo 38
2. Special Subjects 38
   (*a*) Board of Agriculture in India 38
   (*b*) Agricultural Education 40
   (*c*) Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures. 42
   (*d*) Engineering 44
   (*e*) Dry-Farming 46
   (*f*) Sericulture 48
   (*g*) Poultry 48

Part V.—Publications and Expenditure 49

(1) Publications 49
(2) Expenditure 50

Appendix.—List of Agricultural Publications in India during 1911-12. 53



AGRICULTURAL COLLEGE AND RESEARCH INSTITUTE, PUSA.

REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1911-12.

INTRODUCTORY.

As has been customary in the past, I propose to summarise in this introductory chapter a few of the more notable and interesting achievements, leaving the reader to seek further information in the body of the report and the publications of the Department.

Cotton.—The efforts of the Department in cotton have remained unabated and improvements have spread rapidly. In Bombay approximately 20,000 acres have been sown with improved cottons with the seed of which it is expected ultimately to influence some 2,000,000 acres. In Madras a system of seed distribution has been built up in the Tinnevelly District for the spread of the pure Karungani variety with the result that there are now vast tracts of this improved cotton, and the cotton trade of Madras has consequently been greatly improved. The crop of the Cambodia variety is estimated this year at 80,000 bales of the value of 150 lakhs of rupees as compared with 33,000 bales in the previous year. The increase of the area of cotton in this Presidency during the past two years has amounted to 600,000 acres and the present area exceeds that of any previous year by nearly 300,000. In the Central Provinces 'Buri' cotton, which has a reputation of being resistant to the wilt disease, and a selected local strain of *roseum*, are being spread over very large areas, bringing increased profits to the

cultivators. In the United Provinces a white-flowered variety, giving 19 per cent. more seed cotton than the other existing varieties, is being distributed to cultivators, and it is estimated that the 2,000 acres grown last year from pure seed will this year be increased to 20,000 acres. In the Punjab preparations are being made for the spread of improved varieties and the new Canal Colonies about to be opened offer facilities for the production of high grade cotton on a large scale. All that the Department can reasonably be expected to do is being done and an improvement in the general standard of the crop is being effected. That the problem of cotton improvement in this country is not altogether bound up in its quality or in increasing the length of its staple has before been pointed out, for it is generally found that increased yield and increased ginning percentage combined with hardiness of habit in the plant means more money for the cultivator than mere length of staple. There is evidence that on the whole the cotton now grown is inferior in quality to that of many years ago. But the mere quality of cotton taken apart from the yield is not a true indication as to whether cotton cultivation is doing well or not. We must consider the yield as the chief factor, and looking at the position from this point of view there is every cause for satisfaction.

Wheat.—The improvement of this crop, both in respect of its quality and yielding power, continues to engage the attention of Mr. and Mrs. Howard at Pusa. Extended trials go to confirm previous results and give prominence to the fact that in this plant high-yielding power and good-grain qualities can be combined. For an adequate account of the work the body of the report dealing with this crop should be read.

Sugarcane.—A most important development has occurred this year in the treatment of this crop, by the establishment of a cane-breeding station in Madras and the appointment of Dr. C. A. Barber to be in charge of the station for five years. This is the result of the advice given by the Board of Agriculture in India which in its last session recommended "the establishment of an acclimatisation and cane-breeding station in Madras." The fundamental problem in the saving of the

SUGARCANE UNDER ONE YEAR OLD RAISED FROM SEED IN MADRAS.

Indian Sugar Industry lies in better cultivation and the introduction of canes possessing a larger percentage of sugar and higher purity of juice. The canes of India from which sugar is made are of a low quality, and in order that the full benefit of modern developments in the shape of central factories may be successful it is necessary to raise the quality of Indian canes. This the Cane-breeding Station in Madras is expected to do. While in India at the present day it takes some 15 to 16 maunds of cane to make a maund of sugar, in other countries the same quantity of sugar can be made from 10 maunds of cane. In consequence of the low sugar content of Indian canes, the cane expenditure on a given weight of sugar is greater in India than in any other country in the world. From this it is easy to understand the very great importance which the breeding of canes has in the problem before us. Dr. Barber has not only made a collection of the important canes of India, but has already raised a very large number of new seedlings which will this year be available for experiment in the sugar tracts. The appointment of Mr. William Hulme as Sugar Engineer for three years is another step in the direction of assistance for the Sugar Industry. His attention will be directed mainly to studying methods of manufacture and to determining the improvements that are required on the mechanical side. He is this year conducting a trial in Pilibhit in the United Provinces with a factory fitted with modern machinery and capable of crushing 100 tons of cane per day of 24 hours. A further suggestion of the Board of Agriculture was that of the establishment of a sugarcane station in Bihar, where already some eight central factories have been put up of recent years and four more are in contemplation. This has been favourably considered by the Local Government and the station should be opened this year. A sugarcane station is being established also in Shahjahanpur in the United Provinces. In Assam a survey is being made in the Goalpara and Kamrup Districts, where the lands and climate are suitable, with a view to the establishment of the central factory in those parts.

Groundnut.—The area under groundnut, which in 1905-06 was under half a million acres, rose to over 1,200,000 acres in

1911-12. The increase coincides with the expansion of the Agricultural Department to whose efforts it may be attributed. In Madras there has been great improvement in yield; in Bombay the area has expanded and in some tracts the demand for seed is greater than the supply. In the Central Provinces, where it was unknown three or four years ago, a large area is now grown in Chhattisgarh, and in the United Provinces, where till recently the crop did not exist, over 20,000 acres are being cultivated, with certainty of rapid extension. In Burma the crop has risen in area to over 140,000 acres.

Fruit Experiments.—The fruit experiments which are being conducted in Baluchistan by Mr. and Mrs. Howard are assuming important proportions. A fruit station has been established about two miles from Quetta and last year most promising results were obtained in the transport of fruit of first quality, over long distances, to many parts of India, in non-returnable boxes.

Palm-Sugar.—It is not generally known that nearly half a million tons of sugar are produced yearly from the palm in India, and Mr. Annett's work on this subject has indicated the possibility of there being a considerable future for this industry in improved methods of cultivation and of treatment of the juice. Mr. Annett found the juice to contain 8 to 10 per cent. of sucrose associated with practically no glucose, which shows it to be an exceedingly good material for the production of white sugar direct from the juice. The possibilities are further exemplified by comparison with the sugar produced in America from the juice of the maple which contains only 3 per cent. of sugar.

Veterinary Pathology.—Consequent on the abolition of the post of Inspector General, Civil Veterinary Department, the Muktesar Research Laboratories and the publication of Veterinary scientific work have been placed under the control of the Agricultural Adviser to the Government of India, with effect from 1st April 1912.

Cattle disease is so serious an affliction that it ranks in many parts of India as a scourge and is a direct obstacle to the

amelioration of the condition of the cultivator. A sudden epidemic of rinderpest will in one stroke waste his hard-earned savings and deprive him of the means of carrying on his cultural operations. A new pair of bullocks will have to be purchased and he will be driven once more into the hands of the money-lender whom it will be difficult to repay, should there be an early recurrence of an attack.

There are tracts in India which are entirely depopulated of their cattle by disease, on an average, every five or six years. No one knows better than the apostle of the Co-operative Credit Society and of Cattle Insurance the disability under which the cultivator lives where cattle disease is common. It was for this reason that the Conference of Registrars of Co-operative Credit Societies which sat in Simla last October recorded in its proceedings a resolution that cattle insurance should not be undertaken unless adequate means existed of applying prophylactic measures against disease, because of the certainty of bankruptcy. In this way, we have an authoritative recognition of the important part cattle disease plays in rural economy. With a view to combating cattle disease, Government have put up, at Muktesar in the United Provinces, Laboratories for Veterinary research and the manufacture of sera, at an expenditure of over 40 lakhs of rupees, and have manned them with an efficient, though somewhat inadequate, staff.

The efficiency of the control of disease by inoculation is shown in the body of the report, in the relatively low figure of mortality among inoculated animals. The reports show that there is considerable progress being made and that cattle-owners are rapidly appreciating the value of inoculation. What, however, is wanting is a greater number of Veterinary Assistants and a large staff of inoculators to cope with outbreaks on an extended scale. Attention to this defect is most urgently called for.

Economic Development.—As in previous years, I have to record the inadequacy of the present staff to cope with the ever-growing needs of the Department. With the spread of education, to which a stimulus is now being applied, and the

desire which exists of improving the condition of the people, corresponding assistance seems called for in the sphere of economic development. Unless this is given, a condition of affairs will be created wherein the better educated will not have suitable material to which to devote their minds, and there will result the anomalous spectacle of a highly educated people in an undeveloped country. One cannot but feel that already political issues and the problems of education are drawing the minds of the educated and ruling classes away from thinking of economic schemes, to those of purely theoretical merit, and the almost entire absence of assistance from private benefactions in the cause of agricultural improvement lends colour to this belief. I, therefore, venture to suggest, in the interests of this Department whose aim is to improve rural economy and which deals with that industry which fundamentally affects the well-being of the people, that a liberal measure of assistance, not only from Government, but from public benefactors, is required if the work of economic development before us is to be adequately carried out.*

In England, the Development and Road Improvement Funds Act was passed in 1909 by which large sums of money were set aside for economic development, such as for "aiding and developing agriculture and rural industries by promoting scientific research, instruction and experiment in the science, methods and practice of agriculture, the organisation of co-operation, instruction in marketing produce, and the extension of the provision of small holdings, and by the adoption of any other means which appear calculated to develop agriculture and rural industries." It has also other objects, such as the development of forests, harbours, fisheries, "and for any other purpose calculated to promote the economic development of the United Kingdom." The creation of such a fund for such a purpose is recognised as being sound finance, for it prevents the stoppage of productive and beneficial undertakings, in times of financial stress, and aids in secure and continued progress. The creation of such a fund in India would be an inestimable

* Since this report was written the grant by Government of 10 lakhs of rupees for agricultural expenditure has been announced.

boon and a fitting compliment to the policy of reform and education already in hand.

I have to thank Mr. A. C. Dobbs, Assistant to the Agricultural Adviser to the Government of India, for the preparation of this report.

BERNARD COVENTRY,
Agricultural Adviser to the Government of India.

PUSA, BIHAR;
The 23rd January 1913.

PART I.

Development of the Work of the Imperial Department of Agriculture.

1. *Office of the Agricultural Adviser to the Government of India.*—The post of Inspector General of Agriculture in India was held by Mr. Bernard Coventry, C.I.E., till the end of March 1912, when the two posts of Inspector General of Agriculture in India and Director of the Agricultural Research Institute, Pusa, were amalgamated into one of Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa, Mr. Coventry holding charge of the combined offices. At the same time with the abolition of the appointments of Inspector General of the Civil Veterinary Department and Reporter on Economic Products to the Government of India, the immediate control of the Imperial Bacteriological Laboratory at Muktesar, the supervision of the publication of Veterinary Memoirs and the charge of the Ledger Files on subjects in which the Agricultural Department is interested, have devolved on the Agricultural Adviser. Mr. A. C. Dobbs, who was formerly Assistant Inspector General of Agriculture in India, held the post of Assistant to the Agricultural Adviser till 28th April 1912, when he proceeded on six months' combined leave.

2. *Tours.*—As usual, much of the time of the Agricultural Adviser was spent on tour. During the early part of the year under report he visited the Agricultural Stations of the Madras Presidency and the Central Provinces, as well as some of those in the Bombay Presidency, and inspected the important work which was being done by these departments in the improvement of cotton, wheat and sugarcane. In November 1911, he presided over the seventh meeting of the Board of Agriculture which was held at Pusa. In January 1912, he visited the sugar factories and sugarcane plantations in Bihar, and in February he toured in Eastern Bengal and Assam with a view

to seeing the work done on the experiment stations of the Department of Agriculture and of the Indian Tea Association, and to get a general idea of the suitability of the large uncultivated tracts of the Province for the extension of sugar cultivation and for the establishment of central sugar factories. In March he visited the Flax Experiment Station at Dooriah in order to discuss on the spot the prospects of the flax industry in Bihar, and in April he inspected the Agricultural Station of the North-West Frontier Province at Tarnab (Peshawar). Besides these tours of inspection, the Agricultural Adviser visited Calcutta and Simla to attend the meetings of the Board of Scientific Advice as well as to confer with the Government of India.

3. *Agricultural Research Institute, Pusa.*—An account of the work in progress at Pusa has been given in the report of the Institute, and it is only necessary here to draw attention to a few points of interest.

(*a*) **Administration.**—The amalgamation of the posts of Director of the Institute and Inspector General of Agriculture in the post of Agricultural Adviser, from April 1st, 1912, set Dr. Butler free to devote his whole time to the Mycological Section. The extra work thrown on the Agricultural Adviser has been lightened by the revival of the post of Imperial Agriculturist, which Mr. Milligan took up in May, thus setting Mr. Dobbs free, after his return from leave, to devote his whole time to his duties as Mr. Coventry's Assistant.

Mr. and Mrs. Howard continued their work in Baluchistan where they spent the five months from May to September.

The recognition of the pathological quality of Mr. Howlett's work in Entomology has resulted in the addition, by the Administrators of the Medical Research Fund, of three posts to his staff, thus setting other members free to devote themselves to work of more direct import to agriculture.

There has been no essential change in the administration of the Chemical and Bacteriological Sections.

(*b*) **Training.**—It is gratifying to be able to record for the first time the admission of private students to the post-graduate

course; there are now three such students at the College, two studying Chemistry and one Entomology. The total number is not great but is, so far as it goes, an indication of a genuine demand for higher scientific training for agricultural purposes.

(*c*) **Agriculture.**—It has perhaps hardly been sufficiently recognised in the past that the sciences of chief importance in agriculture are Economy and Engineering and with the increase of specialisation the scientific work left to the Agriculturist can be summarised under those heads. The revival of the post of Agriculturist at Pusa and the appointment of Mr. Milligan, who has been so successful in introducing labour-saving implements in the Punjab, ensure that these two allied aspects of agricultural experimental work will no longer be neglected.

(*d*) **Chemistry.**—Mr. Annett's work on the Date-Palm Sugar Industry indicates that there may be a considerable future before the systematic cultivation of date-palms for purposes of sugar production. In spite of very defective methods of cultivation and subsequent treatment nearly half a million tons of date sugar are produced yearly in India and the possibilities are illustrated by the fact that sugar is made in America from maple juice which contains only one-third of the percentage of sugar found in the palm tree juice,—which latter is also of great purity. A memoir on this subject is in the press.

The results of Dr. Leather's work on the composition of milk promise to be far the most consistent and valuable of any data on the subject so far obtained in India.

(*e*) **Botany.**—The development of Mr. and Mrs. Howard's work on wheat and tobacco is recorded in the sections devoted to these crops below.

It may be noted that the promising results obtained by selection of gram, referred to in the report of the Pusa Institute, are a by-product of scientific investigations of natural cross-fertilisation recorded in the Botanical Memoirs.

In Rozelle (*Hibiscus sabdariffa*), the Howards have recognised a useful plant for the illustration of Mendel's hypothesis of the discontinuity of plant characters and their recurrence in accordance with the law of probability after crossing.

The demonstrations in connection with the Tirhut Agricultural Exhibition illustrate the adaptation of methods of education to local circumstances.

In Baluchistan, a Fruit Experiment Station has been partially laid out and most promising results have been obtained in the transport of fruit over long distances in non-returnable boxes selected after experiments in 1911.

The absence of the Howards from Pusa for five months in the year in connection with their work in Quetta is partially compensated for by the possibility of utilising the summer season in Quetta for growing a second generation of Pusa cold weather crops. Thus, a year has already been saved in obtaining a desirable wheat cross, as mentioned in the last paragraph of Part II of Mr. Howard's section of the Pusa Institute Report.

(*f*) **Mycology.**—The least conspicuous but perhaps most important part of Agricultural Mycology at present is the preliminary spade work of the distinction and classification of plant parasites and the study of their life-histories and reactions. Progress in the former direction is marked by the publication during the year of two parts of a list of Indian fungi, containing a record of over 300 species of Indian fungi, many of which were described in detail, over a hundred being new to science. Several important fungi have been studied in detail.

The occurrence of "potato disease," caused by *Phytophthora infestans*, in Lower Bengal, and of a disease resembling the "sereh" of sugarcane, which is exceedingly destructive in Java but hitherto unknown in India, has to be regretfully recorded.

Dr. Butler's possibly very important discovery, in the course of a microscopical examination of paddy affected by the disease called *Ufra*, of an eelworm, present in all the diseased plants examined, is referred to in the section devoted to that crop below.

(*g*) **Entomology.**—The combating of insect pests by direct action presents peculiar economic difficulties, success depending on extreme thoroughness in execution, and it is therefore satisfactory to be able to record at least two distinct economic suc-

cesses, obtained through the medium of the Bihar Department of Agriculture—the protection on a large scale of potatoes from potato moth by storage in sand, and the salvage of a large acreage at Mokameh from the usual destruction caused by the caterpillar of the " silver Y " moth *Agrotis ypsilon*, by means of hand-picking and the use of traps for the moth. The indirect method of attack by encouraging the natural enemies of a pest has become a part of the normal procedure in dealing with the bollworm in the Punjab and has been introduced against the same pest in Egypt. This method would seem to be capable of great development.

The permanent acclimatisation of American-Italian bees introduced from England and found a great success from the honey-gathering point of view has been barred by failure hitherto to obtain fertilised queens from the hives imported.

(*h*) **Pathological Entomology.**—The chief feature of the development of work in this section during the year has been the growing recognition of its importance from the medical point of view. Mr. Howlett gave a five weeks' course of instruction to seven medical officers deputed to the Stegomyia Survey, and acted as Secretary to the Entomological Sub-Committee appointed by the Malaria Conference in Bombay.

The entomological aspects of Veterinary Pathology have not been forgotten and the study of the bionomics of biting flies in general promises interesting results.

(*i*) **Agricultural Bacteriology.**—As Chemistry stands to the material, so Bacteriology stands to the biological qualities of soils. The fertility of a soil may be due as much or more to the mechanical treatment it receives and which radically alters the conditions of life in the soil, as to its inorganic chemical composition which affects them in perhaps a lesser degree.

The study of soils from a biological aspect thus comprehends the study of the physical and chemical factors in one. The work is necessarily highly technical, but a reference to Mr. Hutchinson's section of the Report of the Pusa Institute shows that considerable progress has been made, particularly in the study of the conditions under which organic nitrogen is converted into nitrates and ammonia in the soil.

PART II.

Progress in the Provinces.

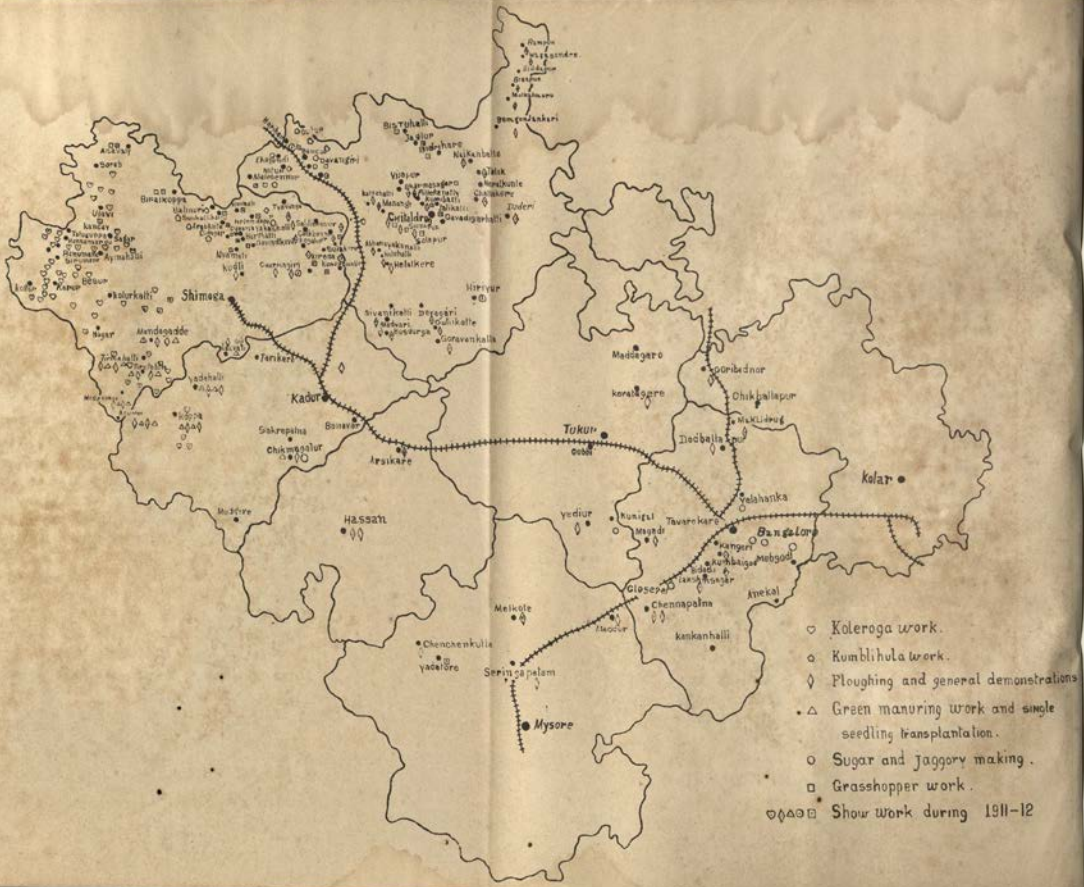
1. *Bombay.*—Mr. Smart succeeded Mr. Keatinge as Director of Agriculture in Bombay in November 1911. A second Deputy Director of Agriculture was appointed during the year, and has worked as Assistant to Mr. Main in the Presidency. From October 1st he was to take sole charge of three of the Divisions formerly worked by Mr. Main, and an extra Deputy Director has been sanctioned to take charge of the Konkan at the same time. The Professor of Agriculture was also to be relieved of the district in his charge, so that he might devote more time to teaching in the College.

Mr. Henderson, Deputy Director of Agriculture in Sind, was on leave for November and December 1911, during which time he visited the cotton tracts in the United States. The final report on his reclamation of 400 acres of the worst kind of salt land is being published as a bulletin.

Mr. Musto, the Agricultural Engineer, during two months' leave in England made a private study of steam ploughing. The importance of this officer's work is referred to in the section on Engineering in Part IV of this report.

The work of this Department in introducing and improving cotton, and on dry-farming methods, is also referred to under the appropriate sections.

2. *Madras.*—Mr. G. A. D. Stuart acted as Director of Agriculture in Madras for almost the whole of the year under report, Mr. Couchman being absent on furlough. Mr. Sampson, after his return in October from six months' leave, spent the rest of the year on special duty in connection with a Cattle Survey of the Presidency, Mr. Southern continuing to act for him as Deputy Director. Mr. McRae has been confirmed in his appointment as Mycologist, and the appointment of a European Entomologist having been sanctioned for five years was filled by Mr. Bainbrigge Fletcher from April 1912. Application has been made for the appointment of an Assistant Prin-


Shimoga
Kadur
Tukur
Hassan
Bangalore
Kolar
Mysore
Koleroga work.
Kumblihula work.
Ploughing and general demonstrations
Green manuring work and single seedling transplantation.
Sugar and Jaggory making.
Grasshopper work.
Show work during 1911-12

cipal and of an Economic Botanist to be independent of the College.

It is thus seen that the Madras Department is maintaining the superiority in numbers of staff referred to in last year's report, and while the comparative success of the College goes towards justifying the concentration of a large proportion of the staff on the College work, the increasing numbers of the staff make this proportion much less than is the case in other Provinces where the Colleges appear to be proving less successful.

As regards scientific work, Mr. Harrison has recently published in a memoir an account of his work on *Black Cotton Soils* in which he has shown that the characteristic colour is due to two compounds universally present in such soils whatever their origin. One of these compounds is colloidal in nature, probably a hydrated double silicate of iron and aluminium, and possesses in a modified form the properties of ordinary clay; the other is organic,—possibly an organic compound of iron and aluminium.

But it is no disparagement to the work of the Madras Department to say that it has consisted chiefly in the extension of that referred to in last year's report. A development which has come to the fore is the popularisation of the growth of green manuring crops in Tanjore and Madura. Much is to be expected in the future from the establishment of relations between the Agricultural and Co-operative Departments referred to in the section on " Demonstration " in Part IV of this report.

3. *Mysore.*—Dr. Coleman was in charge of the work of the Mysore Agricultural Department as Mycologist and Entomologist during almost the whole of the year, handing over charge to Mr. Krishnayya at the end of May. It is a pleasure now to be able to record the retention of Dr. Coleman as head of the Department in the office of Director of Agriculture. The work of the Department has consisted chiefly in an extension of that mentioned in last year's report—the demonstration of improved practices, and organised campaigns against plant diseases and pests. The map opposite gives a good idea of the activity of

the Department. The " Koleroga work " consists in spraying areca gardens with Bordeaux Mixture in order to prevent the attack of the fungus *Phytophthora omnivora* var. *arecæ* which causes *Koleroga.*

Kumblihula is a moth which is got rid of by hand-picking and deep ploughing.

In connection with these demonstrations, the following publications were issued during the year :—

(1) *Green Manuring in Mysore;* General Series—Bulletin No. 1.
(2) Experiments on Paddy Cultivation; Bulletin No. 2.
(3) *Kumblihulas;* Entomological Series—Bulletin No. 3.
(4) *Koleroga of Supari,* a pamphlet in Kanada containing full instructions for spraying and preparing spraying solutions, intended for local distribution.
(5) A Kanada leaflet on the Cultivation of Broach and Cambodia Cotton.

The introduction of Cambodia cotton will perhaps prove to be the greatest immediate economic advance. An experiment showed that as much as 60 maunds of seed cotton per acre could be produced on rich garden land, and seed sufficient to sow 1,255 acres of Cambodia and Broach cottons was distributed.

The establishment of an Agricultural School in Bangalore has been decided upon.

4. *Central Provinces.*—In the Central Provinces, the senior staff of the Agricultural Department remained unchanged during the year. The keynote of the work of this Department for the present is economic efficiency as the following extracts from the Director's Annual Report show :—

> " The financial results of the season's working (of the Akola Farm) were an expenditure of Rs. 13,957, receipts of Rs. 19,167 and a net profit of Rs. 5,210, after paying all charges, staff included. This gives a net profit of nearly Rs. 20 an acre, which could be considerably increased were the farm managed simply as a cotton-seed-producing centre. The large experimental area increases the expense and

detracts from the receipts. The farm, including land and buildings, which last were designed on a rather lavish scale, cost between Rs. 80,000 and Rs. 90,000, so that it is clear that it would be easy to pay 10 per cent. or more on a cotton seed farm. * * * * * * *

"The Telinkheri Cattle-breeding Farm has again beaten all its previous records financially, by yielding a net profit of Rs. 2,134. Two bulls were sold for Rs. 200 each, the highest price obtained so far by the Department. It is clear that purchasers are more ready than they were to pay a good price for a good breeding animal: and so far as its very limited size allows the farm is attaining its object. * * * *

"The grass reserve at Nawagaon showed a net profit of Rs. 1,506, which is three or four times as much as the price previously obtained from contractors, when it was annually leased out by the Deputy Commissioner. The cutting of spear-grass at an early stage of its growth is the main object of demonstration, and this year the hay found a ready sale among local cultivators, a great contrast to the difficulty experienced in selling it last year. The small Chhattisgarhi cattle fed on the hay are now as large as they are ever likely to be, and in fine condition."

As a means of getting into touch with the cultivator, there is probably nothing so effective as this demonstration of the cash value of improved practices.

Scientific work at Nagpur has been hampered by the fact that the research laboratories are not yet ready, and it is to be feared that when the more obvious agricultural improvements have been ascertained on the farms and demonstrated by the efficient methods in which this Department excels, there will have to be a halt pending the evolution of less obvious improvements, *e.g.*, the production of improved strains of crops not now existent.

As regards the College work, the Director remarks that the absence of students of agricultural castes is beginning to have its effect both on the College and among the Demonstration Staff.

5. *Bengal.*—The redistribution of areas between Bengal, Assam and Bihar has created some difficulty in the work of the

present Bengal Department, Mr. Meggitt having had to give up his work at Jorhat in Assam, referred to in the next section below, and take up work in Bengal. Mr. Meggitt's work on soil acidity at Dacca is interesting and goes to show that even such a large dressing of lime as 30 to 60 maunds is unable to remedy the acidity at a greater depth than 6 inches from the surface. The isolation of 150 single line cultures of rice by Mr. Hector is a promising beginning of work on this exceedingly important crop. Similar work has also been undertaken on oil-seeds—the other most important group of crops on which practically no scientific work has hitherto been done in India, and great results may be looked for from these two lines of enquiry, if steadily persisted in. Mr. Finlow has continued his work on the selection of jute varieties and his experiments with Sida.

The retirement of Mr. Hart from the office of Director of this Department is to be regretted. Mr. Blackwood has been Director since the beginning of May 1912. Mr. T. Southwell joined the Department as Deputy Director of Fisheries in December 1911, and has familiarised himself with the present status of fish culture in the Province and in Bihar, but is hampered by the want of a steam launch which is indispensable for the systematic investigation necessary.

6. *Bihar and Orissa.*—After the separation of Bihar and Orissa from Bengal, Mr. Heycock remained Director of Agriculture in Bihar and the College at Sabour became the focus of the Bihar Department.

Only eleven new students joined the College in June 1912, the majority of the 41 applicants withdrawing on realising that a Government appointment was not the necessary reward of taking the diploma.

The scientific work at Sabour has consisted chiefly of the classification of varieties of crops and the investigation of their characters by Messrs. Woodhouse and Taylor in collaboration. Thus, thirty varieties of sugarcane have been isolated and their growth and periods of ripening studied in detail, and these formed the largest single contribution towards the collection made by Dr. Barber for the new Sugar Station. Similarly, the

indigenous soybeans have been classified by their botanical characters and their oil content ascertained, and an account of the work has been prepared for publication as a Memoir. Other pulses are also being studied in detail in single plant cultures.

As regards demonstration work, great success has been achieved in promoting the storage of potatoes in sand to avoid the potato moth and in the salving of some 7,000 acres at Mokameh from the surface caterpillar of *Agrotis ypsilon*, accounts of which have been published in the *Agricultural Journal of India*, Volume VII of 1912, July and October numbers respectively.

Mr. Taylor has successfully reorganised the well-boring work in the Patna Division where there appears to be a promise of useful expansion.

7. *Assam.*—The superior staff of the Agricultural Department in this Province has been reduced, as a consequence of the re-partition, to the Director, now Mr. J. McSwiney, and the Deputy Director, Mr. A. G. Birt.

Work on the farm at Jorhat carried out by Mr. Birt and Mr. Meggitt before the partition showed the value of liming on the acid soil of the farm and proved the suitability of some of the Barbados seedling canes for the district.

At Upper Shillong, experiments were tried with potatoes, fruit and fodder crops.

Demonstrations of the effect of manuring winter rice with bonemeal resulted in the sale of 127 maunds to cultivators in the Khasi Hills, and the practice is spreading. Attempts are being made to cheapen the supply of bonemeal. The value of spraying potatoes to prevent disease has also been successfully demonstrated in the Khasi Hills.

Fruit-growing is being successfully introduced in the Lushai Hills. The success of the introduction of improved poultry into this district is referred to in the section on Poultry in Part IV of this report.

8. *United Provinces.*—Mr. Moreland having gone on leave in November 1911, Mr. Molony and Mr. H. R. C. Hailey have

successively held charge of the office of Director of Agriculture in the United Provinces during the year under review. The principal developments on the administrative side have been the appointment of an Assistant Economic Botanist and an application to Government, for the permanent appointment of an Agricultural Engineer owing to the inability, referred to in last year's report, to obtain a man from the Public Works Department.

As regards research, Mr. Leake has continued his work on cotton selection, and the improved types he has isolated are being tested on a field scale on a farm recently acquired at Aligarh. Wheat work comprised the testing of some of the Pusa wheats under irrigation and the experiments on the influence of environment on wheat referred to in the section devoted to that crop below. A survey of the Provincial wheats is now approaching completion.

Mr. Clarke's investigations on sugarcane have been continued and a small farm is being opened in the Shahjahanpur District to provide a more suitable field for this work. An investigation of the organic phosphorus compounds of wheat and other plants is being carried out and may have important results in connection with variation in the qualities of flour.

Other experimental work included the testing of different methods of cultivation of wheat, cotton and maize.

The *ex*tensive work of the Department consists chiefly in the distribution of wheat seed through the Oudh seed depôts. Arrangements have also been made for the distribution at Aligarh of a white-flowered type of cotton of high ginning percentage. A large amount of groundnut seed was also distributed. The distribution of implements has reached such dimensions that in addition to Cawnpore firms, two Calcutta firms have opened branches in Cawnpore for their sale.

A large number of wells were bored by the Boring Department, but there is some doubt as to the efficiency of the organisation.

9. *Punjab.*—The superior staff of the Department in this Province is still below sanctioned scale and progress outside

Lyallpur and Gurdaspur is seriously hampered by the want of a second Deputy Director and of an Agricultural Engineer. The staff, moreover, suffered a great loss by the transfer of Mr. Milligan, Deputy Director, to Pusa as Imperial Agriculturist. It will necessarily be some time before Mr. Southern, who has taken his place, has acquired the local experience necessary to enable him to fill the gap.

The post of Assistant Mycologist was abolished during the year and that of Assistant Entomologist was filled by the appointment of Lala Madan Mohan Lal on the completion of his training at Pusa. In the absence of a whole-time Entomologist he will work under Mr. Milne, the Economic Botanist.

The Financial Commissioner is inclined to doubt whether the problem of safeguarding cotton from bollworm and sugarcane from moth-borer has been tackled with sufficient energy: but the comparative ignorance of the causes of the abnormal variations in the frequency of these insects which make them so serious can only be due to a want of research into the facts on the spot, and can hardly be adequately remedied by the appointment of an inexperienced student as Entomological Assistant to the Economic Botanist, 'practically the whole' of whose time (to quote his own words) has been hitherto taken up with teaching and other duties connected with the College.

During the past two years 3,000 offshoots from the best varieties of Arabian date-palms have been imported from Basra and have been planted for the most part in model plantations at Multan, Muzaffargarh and Dera Ghazi Khan. There is also a plantation in the botanical area at Lyallpur. Suckers imported in 1912 have already produced fruit at Multan and Lyallpur, and so the success of this work will shortly be put to the test. The combination of the necessary conditions of great heat, plenty of water, and practical rainlessness, particularly during the ripening period, which prevail over the Southern and Western Punjab, is of happy augury for such success.

The demonstration of the use of the implements adapted to local conditions under Mr. Milligan's supervision is now an important part of the work of this Department. Apart from

reapers, iron-ploughs, large and small, and implements for surface cultivation (hoes and harrows) have been successfully introduced and are being popularised.

10. *Burma.*—Mr. MacKenna returned from leave and resumed his work as Director of Agriculture in Burma during the year under report. The Province has been divided into two Circles under the Deputy Directors, Mr. Thompstone being in charge of the Northern and Mr. McKerral of the Southern Circle. Apart from the supervision of the Mandalay Agricultural Station, Mr. Thompstone's time has been largely taken up with educational work in connection with the proposed creation of a staff of District Agriculturists referred to in the section on Education in Part IV of this report.

Mr. McKerral has been chiefly employed in making agricultural surveys of the Yamethin and Insein Districts in the course of which much interesting and useful information has been accumulated. He is also in charge of the Hmawbi Agricultural Station.

A lack of trained subordinates who could conduct local demonstrations and experiments prevents any great developments in these directions.

Mr. Warth, Agricultural Chemist, has completed a chemical examination of paddy mill products after devising and testing methods for their analysis, and a paper on the subject is under preparation.

Mr. Sawyer, assisted by Mr. Thompstone, completed an exhaustive survey of the peas and beans of the Province and a survey of the wheats is almost complete.

Interesting work in Entomology has been done by Mr. Shroff who has found a parasite of the mango weevil and is engaged in working out its life-history.

A significant feature of Mr. Shroff's work is his success in getting rid of the swarming paddy caterpillars by the simple process of attracting paddy birds to the affected areas. If such indirect methods of attacking insect pests by the culture of their enemies, parasitic or rapacious, could be extended, they would not only perhaps be more effective than the more direct

method which requires extraordinary thoroughness in execution, but would also popularise entomology among the Burman Buddhist who is averse to taking the life even of an insect—an aversion which now causes great difficulty in obtaining Assistants for the Entomological Laboratory.

11. *North-West Frontier Province.*—In the North-West Frontier Province, Mr. Robertson-Brown has continued his work on the selection of crops, fruit-culture, and improved methods of soil cultivation. Trials are being made of some of the Pusa wheats, and striking success has been achieved with English oats, an account of which has been given in the *Agricultural Journal of India*, Volume VII, October 1912.

Local varieties of sugarcane are being grown under observation and imported varieties tested.

Some remarkable yields of indigenous cottons—up to 20 maunds per acre of seed cotton—are reported by Mr. Robertson-Brown from a tract in the Peshawar District which is said to be famous in the North-West Frontier Province as producing heavy crops of high class cotton.

12. *Baroda.*—Mr. M. A. Sitole has continued in charge of the Agricultural Department of Baroda. Want of rain and consequent scarcity affected the work of the Department, the most important branch of which may, therefore, be said to have been the boring of wells. Of 119 bored, 94 gave a good supply of water.

Over 1,700 cattle were saved from death from starvation or neglect in cattle camps opened for the purpose in Arkati and Waghmal.

A large number of selected seeds were distributed from the farms at Vakal and Jagudan.

PART III.

Progress in Veterinary Work.

Turning abruptly from the consideration of Agricultural to that of Veterinary progress, the first thing that strikes one is the essential difference between these two branches of applied

science. Agriculture is concerned with the development of the normal, Veterinary Pathology with the control of abnormal phenomena, and we find accordingly that while the energies of the Agricultural Department tend to diffuse over a continually widening field and the results obtained are rapidly lost sight of by absorption in the mass of routine practice; those of the Veterinary Department, as far as Pathological work is concerned, tend to concentrate on a series of more or less converging lines, to each of which corresponds a definite routine system of action on the part of the Department, which is continued, perhaps with improvements, until the extermination of the disease treated.

The keynote of the reports of the Veterinary Department is, therefore, the extension of organisation for, and the degree of success attained in, the control of diseases, and the table opposite shows at a glance what is being done.

On account of this essential concentration of the work on a limited number of lines, there is nothing to obscure the logical consistency of the organisation of the Pathological work of the Veterinary Department towards the end in view.

The method of dealing with any Pathological affection consists in three distinct processes, first, research—the analysis of the effect into its simplest factors and the synthesis of a system or technique of control; secondly, in education—the training in technique of a staff to exercise such control; and thirdly, in the organisation of control.

Thus in the Veterinary Department, we have to begin with the research laboratory at Muktesar, where original investigation is carried on and a large number of scientific diagnoses are made; we then have the colleges where the routine technique of veterinary work is taught; and finally, we have the Superintendents with their Inspectors and Dispensary Assistants, controlling disease throughout the country.

The fundamental condition of success is that research should be successful in evolving the methods of control; systematic training and extensive organisation then present no difficulty except perhaps from the financial point of view.

	No. of superior staff.	Research.	No. of students at end of year.	No. of subordinate teachers.	No. of dispensaries.	No. of Veterinary Assistants.	No. of cases treated in Hospitals and Dispensaries in the year.	Outbreaks reported.	No. of Touring Inspectors.	Cases treated on tour.	Deaths uninoculated.	Inoculations.	Deaths after inoculation.
Punjab	5	Surra	198	.	109	169	241,291	221	15	59,428	2,896	33,087	40
Assam	1	*Nil*	..	..	4	24	3,372	277	2	36,168	7,464	34,942	905
Burma	3+5*	Diagnosis	47	1	1	118	804	54	13	91,274	745	8,946	85
Bombay	3	Chiefly diagnosis	51	..	43	47	87,075	97	3	20,894	1,476	32,573	511
Sind and Rajputana	1	*Nil*	..	..	9	11	16,060	20	1	4,213	495	2,566	8
United Provinces	2+1	Surra; Kumri	..	..	40	140	40,392	397	16	58,372	3,392	44,497	26
Bengal	1	Diagnosis	75	6	18	61	17,289	211	15	52,403	3,125	21,246	74
Bihar and Orissa	1	*Nil*	..	..	23	62	26,681	128	5	44,779	643	16,004	40
Northern Punjab and North-West Frontier Province.	1	*Nil*	..	..	19	26	48,134	50	2	12,671	476	9,037	11
Madras	2+1†	Diagnosis	51	4 ..	20	66	20,252	158	3	5,933	2,270	13,588	17
Central Provinces	2	‡ Diagnosis	..	..	67	90	81,906	416	6	78,591	4,381	68,813	65
TOTAL FOR 1911-12	..	..	422	11	353	814	583,256	2,029	81	464,736	27,363	285,299	1,782
TOTAL FOR 1910-11	..	..	441	24	327	754	531,488	2,836	74	514,919	45,201	307,309	960

* Deputy Superintendent.

† One Assistant Principal and one Deputy Superintendent.

‡ Laboratory incomplete.

As regards research, the treatment of many very fatal diseases has, of course, been more or less stereotyped by previous research which has provided a large amount of routine work limited only by its success in exterminating disease. But there are, on the other hand, many other diseases, *e.g.*, glanders and foot-and-mouth disease, for which no scientific treatment has yet been found and on which further research is essential.

Important investigations made in the year under report are those on the treatment of "Surra," by Mr. Leese, an account of the more recent of which is being published as a Memoir, and by Mr. Oliver, who believes that one-third of the cases treated at Fatehpur have been permanently cured. Mr. Oliver is also investigating "Kumri."

The results of Major Holmes' successful search for a better method of preparing rinderpest anti-serum appear in the increase of the number of doses prepared in the year. The rate of output of this serum has been doubled, without appreciably increased expenditure and at a less cost in animals. Thirty per cent. more doses were issued than in the previous year.

The scientific value of Major Holmes' work has been recognised by the award to him by the Council of the Royal College of Veterinary Surgeons, London, of the Steel Memorial Medal for the year 1912.

Among contributions to research should also be recognised the systematic collection in many Provinces of biting flies which are being sent to Pusa for identification.

The increase of students under training and their steady absorption by the extension of the executive organisation for controlling disease becomes clear from a comparison of the totals for the year under report with those for the previous year at the foot of the table.

Finally, the efficiency of the control of disease by this logically consistent system is shown by the relatively low figures of mortality among inoculated animals—which were presumably inoculated because they were likely to be exposed to infection. (The enormous proportion of the number of inoculations to the

number of the staff in Assam, perhaps, accounts for the relatively high mortality after inoculation there. This insufficiency is about to be remedied.)

We thus see here a healthy progress. Moreover, there is a consensus of opinion that the work is being more and more rapidly appreciated by the owners of cattle. The weakest point appears at present to be the absence of any means of ensuring the immediate reporting of outbreaks, which results in the more rapidly fatal diseases running their course before veterinary assistance can be given. Insufficiency of staff also in many cases—notably in Assam and in the Central Provinces—militates against the efficiency or limits the scope of the Department's work. This fact is generally recognised, and an increase of staff is contemplated in almost every Province.

Breeding Operations.—The breeding operations supervised by the Veterinary Department are in a different category; they consist chiefly in the maintenance of scattered cattle-breeding farms, in every Province except Madras, from which bulls are sold or otherwise distributed; and in supervision of stud animals maintained by Provincial Governments and local bodies. The type aimed at in each case is presumably the best local type, but as to this the reports are uniformly silent. Having regard to the fact that cattle are used almost exclusively in agriculture and that their breeding and feeding are essentially agricultural matters, it is probable that the duty of breeding suitable cattle for each locality will eventually devolve upon the Agricultural Department.

Cattle Survey.—With a view to the improvement of the supply of good cattle, surveys of the status of breeds and breeding have been undertaken in several parts of India.

The Veterinary Department has undertaken what may be called a technical survey, and Manuals have been prepared on the cattle of Southern India, Mysore, Burma, Rajputana, Bombay and the Amritsar District of the Punjab.

A second more general survey has been entrusted to members of the Civil Service or of the Agricultural Department. Reports so far published are that of Mr. Stow on Cattle and Dairying in the Punjab, and a similar report for the Central Provinces.

At a Conference in the United Provinces in 1909, a recommendation was agreed to that the sources of cattle supply and the breeding industry should be surveyed. The importance of such a survey was brought to the notice of Local Governments and those of Madras and of Eastern Bengal and Assam placed officers on special duty in this connection. The reports of these officers are awaiting publication. In Bengal and in Bihar and Orissa steps have since been taken to the same end.

PART IV.

Crops and Special Subjects.

1.—*Crops.*

(*a*) **Cotton.**—In last year's report a reference was made to a note prepared by the Inspector General of Agriculture on cotton investigation in India. A Committee of the Board of Agriculture endorsed this note at the meeting of the Board in November 1911 and concluded their report as follows:—

> "We consider that the best means of aiding cotton cultivation in India have been systematically carried on from the very commencement of the operations of the present Agricultural Department, and we are supported in this conclusion by the account of work done as detailed by Mr. Coventry in his note already referred to.
>
> "The members of the Department now in charge of cotton operations will have their hands quite full enough for some years to come with the task of distributing and maintaining the improved varieties they have so far developed or introduced. In almost all instances, cultivators already appreciate the good qualities of the improved types and (in the Central Provinces at least) are willingly paying enhanced rates for the seed. By unremitting attention to the selection of seed year after year, and by demonstrations of improved methods of cultivation, the general standard of the crop is certain to rise steadily, and for the immediate future, this work, accompanied by the evolution of new types by plant breeding, is all the Department can reasonably be expected to undertake."

A short account of the types of cotton selected or introduced, and of the status of seed distribution in the several Provinces, was given last year. While only one new type, selected in the United Provinces, has risen to importance during the year now under report, the cultivation of the chief of those referred to last year has spread rapidly.

In Bombay, the Syndicate of Cotton Traders which arranged in 1911 to buy up 2,000 bales of the Agricultural Department's selected type of Broach cotton grown in the Surat District at 5 per cent. more than local rates for ordinary cotton, agreed in 1912 to extend their operations and provide ginneries in each of four groups of villages in which some 15,000 acres of this cotton were to be grown. This arrangement obviates one of the chief difficulties in the way of marketing the improved cotton, *viz.*, the long distance from the market.

The short-stapled, high-yielding cotton of the variety *roseum*, referred to in last year's report, is being distributed on a large scale in Khandesh, an improvement which may affect 1,300,000 acres.

Some 40,000 lbs. of Navsari (Broach) cotton seed was distributed in the Southern Maratha Country, and the auction sales organised by the Agricultural Department for the disposal of the produce were a great success. This cotton yields better, gives a higher percentage of lint, and is worth some 40 per cent. more than the local Kumpta; and the only objection to its spread is the necessity for sowing it early in the season, when the rains are uncertain.

In the south-eastern part of the Dharwar District where 200,000 acres of cotton of the American type are grown, selected Cambodia cotton (also of American type) has shown itself a better yielder, particularly under droughty conditions. As the cotton is also generally superior to that now grown, there seems to be no reason why the whole area should not eventually be sown with Cambodia, which, estimated to return Rs. 16 more per acre than the present type, would mean an enormous gain to the district.

In Madras the crop of Cambodia cotton is estimated at 80,000 bales as compared with 33,000 in the previous year, but

the price, owing mainly to admixture of other cottons, has dropped to the level of Tinnevelly cotton or even below it. This mixture was probably inevitable in the present stage of rapid expansion of the new type, but as Cambodia has succeeded wherever tried under suitable conditions, there can be no doubt that it will become permanently established and that the inferior local cottons which are easy to distinguish and yield much less will be weeded out. The increase of the area of cotton in the Province by nearly 600,000 acres in the last two years, so that it now exceeds the area grown in any previous year by nearly 300,000 acres, is probably due largely to the introduction of this type.

As suggested in last year's report, the widespread establishment of a cotton of the American type has opened a new vista of possibilities of improvement of the staple by cross-breeding with the best American cotton and subsequent selection.

The area under improved Karungani cotton continues to expand and the quality is maintained. Meanwhile, selection is proceeding on the experiment stations and several good strains of this variety have been established. The production of new types, however, and even the maintenance of those already isolated, requires the appointment of a whole-time Economic Botanist and the necessity increases as the improved types spread.

In the Central Provinces 'Buri' cotton, of a type similar to Cambodia, has established its reputation as a wilt-resistant variety, but is much less paying except under conditions of high rainfall than the selected *roseum*, the distribution of which from Akola and from 40 seed farms in Berar has been such a striking success.

In the United Provinces a white-flowered strain of the local cotton, the superiority of which in yield and ginning percentage has been proved, is being distributed as widely as the seed available permits, and is undoubtedly popular. Mr. Leake is continuing his scientific investigations on the improvement of cotton in the United Provinces and has published a memoir on extra-Indian Asiatic cottons. His memoir on 'Sterility and

Cross-fertilisation in the Indian Cottons' which appeared during the year under report was noticed last year.

The most important development in the Punjab is that of a definite demand in the Lyallpur market for American cotton, at a rupee or more per maund above the rates for the local type. In the North-West Frontier Province, phenomenal outturns of seed cotton—up to 20 maunds per acre—are reported to be yielded by the local variety under irrigation.

(*b*) **Wheat.**—It is probably not too much to say that while much has been done in some of the Provinces towards improving the cultivation of wheat and organising the distribution of pure seed, India is looking to Mr. and Mrs. Howard for the first great step forward—the evolution of types which will at once give a higher yield and be worth grading by distinction of the grain qualities. Some confusion has been caused in the past by the use of the word *quality* in an absolute but uncertain sense, an error from which the section on "Wheat" in last year's report was unfortunately not free. Those who wish to understand the importance of the various material grain qualities of wheat should read Mr. Humphries' report included in the memoir on the 'Influence of Environment on the Milling and Baking Qualities of Wheat in India' by Mr. and Mrs. Howard and Mr. Leake, recently published. Yielding power sums up the desirable qualities of the plant. Strength and the capacities of milling freely and yielding a high proportion of flour of good colour and giving dough of good stability are, perhaps, the most important qualities of the grain. The distinction of degrees of these latter qualities is, perhaps, at once the most important and difficult piece of work in the improvement of wheat grain for the market, just as the distinction of degrees of rust resistance, strength of straw, vigour, etc., goes to make up the work of increasing the yield.

Mr. Howard claims in effect, and has given good reasons for doing so, that perfection of cultivation—the cultivation which gives the highest possible yield—results, perhaps, owing to the elimination of accidental, varying soil factors, in the greater distinction of qualities in the grain; and that the grad-

ing of wheat is, therefore, facilitated by uniformly good cultivation.

But this suggestion becomes of far greater significance in view of the facts as to the inheritance of distinct characters brought to light by Mendel. For, characters once distinguished can be controlled by the knowledge of the law of their inheritance.

An instance to the point is to be found in the most recent of Mr. and Mrs. Howard's memoirs in which it is shown that there are at least two distinct kinds of hairs found on the chaff of wheats, which are inherited separately and can be combined—have been found together and distinct in one wheat. This suggestion, that high cultivation intensifies the distinction of qualities in plants, may, therefore, prove to be one of the most significant explanations of variation in plants ever put forward.

From the economic point of view the work done by the Howards consists, then, in the isolation under good cultivation of various qualities in wheats and the combinations of those economically valuable and not physiologically incompatible. Thus heavy yielding, strong, white wheats have been produced, one of which, Pusa No. 12, has the power of retaining the quality which gives "stability" to the dough to an unusual extent under varying conditions. This important fact emerged in the course of an investigation into the influence of environment on qualities, in which the Howards have obtained the collaboration of Mr. Leake at Cawnpore,—the milling and baking tests necessary finally to determine some of the qualities, being carried out as on previous occasions by Mr. Humphries in England. This investigation has shown in a general way that the influence of environment on the value of the sample grown is one of degree and not essentially significant—it can be overcome, as in the case of the stability of the dough from Pusa No. 12, by what may be called strength or intensity of character on the part of the wheat.

Yields of over a ton per acre of first class wheat have been obtained under both dry cultivation and irrigation. In Bihar

some 1,500 acres of land were sown with the new wheats and yielded over twice the average yield of local wheats. Even if we suppose that a great part of the superiority was due to the better cultivation given to the new wheats, it is clear that they have stimulated this improvement. It is anticipated that between 10,000 and 15,000 acres of these wheats will be grown in 1912-13.

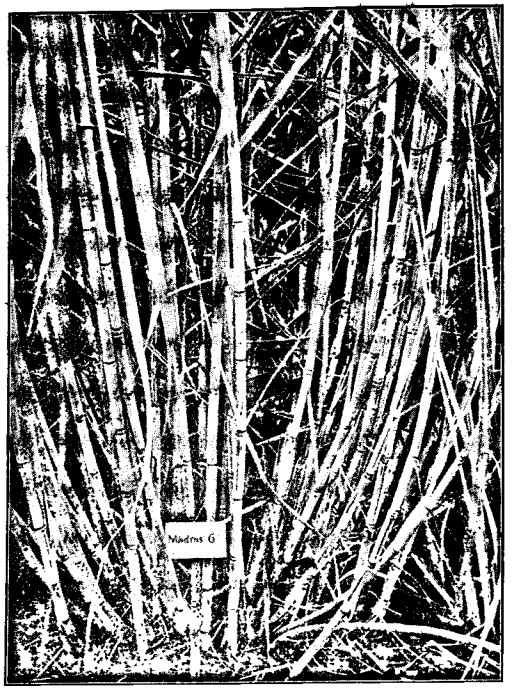
In the United Provinces the distribution of Muzaffarnagar wheat seed from the seed depôts continues. This wheat, in the words of Mr. Hailey's report, " fully maintained its superiority in the Western and Central Doab districts and gave extraordinary yields at the Aligarh Farm." Some Pusa wheats gave high yields at Cawnpore and selections from among them have been made for distribution in parts of Oudh for which Muzaffarnagar has not proved suitable.

In the Punjab, in preliminary experiments made at Gurdaspur, Pusa No. 12 gave as high a yield as any of the local types and has been selected for trial on a larger scale against the best of those types (No. 13 of the originally classified Punjab types).

Yields up to 30 maunds per acre were obtained under dry cultivation; and ploughing 9″ deep gave better results than ploughing $4\frac{1}{2}$″ deep, in each of six plots, the yield from the deeply ploughed plots averaging 2 maunds per acre more than from those ploughed shallow.

In the Central Provinces, there is a demand for soft white *pissi* and for a hard yellow macaroni wheat. Pure seed of selected varieties is supplied through private seed farms and fetches a higher price by 2 seers to the rupee than the market product. There appears to be a small demand, for shipment from Bombay to Jeddah, for a hard bread wheat grown on light soils in the Mandla District.

Good crops and excellent samples of Pusa wheats have been grown by Mr. Clouston at Raipur, notably of a somewhat rust-resistant variety known as Pusa No. 4. Of this Mr. Humphries reported : " The Raipur unirrigated lot is truly superb in appearance; indeed I do not think I am exaggerating if I say it is the finest looking lot of Indian wheat I have ever seen."



SEEDLING CANES UNDER ONE YEAR OLD.

(*c*) **Sugarcane.**—The chief development of the year as regards this crop is the important decision to establish a cane-breeding station in Madras and the appointment of Dr. Barber to be in charge of the station for five years. Dr. Barber has taken time by the forelock, and has not only collected 90 varieties of canes, but has already raised a considerable number of seedlings from canes that flowered in 1911-12 and has made a preliminary study of the conditions affecting fertility and sterility of the flowers. An account of this work is given by Dr. Barber in an interesting article of the *Agricultural Journal of India* for October 1912, in which the importance of raising seedlings in India is explained.

The appointment of Mr. William Hulme as Sugar Engineer for three years is another step towards the development of the Sugar Industry. His work will be in the United Provinces where more than half of the Indian cane is grown and where he will study the indigenous methods of sugar manufacture with a view to determining the best methods of extracting and concentrating the juice for the manufacture of *gur* and white sugar respectively, both on a scale within the means of individuals or small groups of cultivators, and on a scale suited to the resources of capitalists now engaged in the industry in India.

These important steps have been taken in accordance with resolutions passed at the meeting of the Board of Agriculture in November 1911, a short account of which is given below (see page 38).

In other respects the work done has been mainly a continuation of that recorded in last year's report. In the United Provinces the survey and testing of the local varieties have been continued. In Bihar Mr. Taylor has continued his work on the varieties collected in the Province of Bengal before the re-partition, and which provided 30 out of the 90 varieties above referred to as collected by Dr. Barber. At Jorhat in Assam three Barbados seedlings have done exceedingly well, one yielding at the rate of 3·7 tons of cane sugar per acre from a ratoon crop, on a small plot. These varieties appear

to have steadily accommodated themselves to the local conditions. For details of these experiments, the report of the Jorhat Agricultural Station should be consulted. Experiments on the economics of manuring and of crushing cane and making *gur* on a small scale have been in progress for some years in Bombay. Considerable economies have been effected by the use of a small power mill which enables the disposal of the crop to be controlled much better and at less expense than when bullock mills are used. An improved type of furnace for *gur* boiling has also been evolved which can be most economically used in connection with such small power mills. In Madras the area under the Red Mauritius cane distributed by the Agricultural Department has now increased to 3,000 acres at Nellikuppam, where the factory now manufactures sugar direct from the cane. In Malabar the Barbados seedling No. 208 has proved the best variety, and its cultivation is extending; but in the Godavery delta it cannot, owing to liability to disease, compete with the Red Mauritius now almost exclusively grown there.

An interesting account of the use of power mills by rich land-owners in the Coimbatore neighbourhood is given by Mr. Balkrishnamurti in the *Agricultural Journal of India* for January 1912. These mills are driven by oil-engines set up for pumping water.

The work in progress in other Provinces calls for no special comment in this year's report.

(*d*) **Tobacco.**—At Pusa the Howards have developed their work on tobacco. The value of green manuring with *san* for this crop has been confirmed. A modification of the country method of curing has been designed to preserve the yellow colour as much as possible. A selected type, giving a light coloured, fine product, of good texture, and which was favourably reported on by the Peninsular Tobacco Company of Monghyr in 1910-11, has been grown in comparison with coarser, darker, more easily grown types. The product was again favourably reported on and valued at considerably above local prices and a large quantity of seed has been grown for trial

of the type on a large scale, by outside growers. If its cultivation and curing are successfully popularised, the question of fire-curing may be worth considering.

Mrs. Howard has continued her work on the isolation of leaf characters with a view to analysis and synthesis by hybridisation.

It is interesting to contrast this gradual development of the indigenous varieties and methods with the system of introducing foreign varieties and methods pursued at Burirhat in Bengal, where, by the use of regular storing and curing sheds, excellent Sumatra cigar tobacco leaf has been produced on $1\frac{1}{10}$ acres. The curing accommodation is only sufficient for $1\frac{1}{2}$ acres, and though the price of the products is from five to ten times that of ordinary indigenous tobacco, the results must still be looked on as experimental, the expenditure on the farm of 52 acres being over Rs. 8,500 and the receipts less than Rs. 3,000, of which over Rs. 1,500 were realised for 17 maunds of wrapper leaf from the $1\frac{1}{10}$ acres referred to.

In Bombay experiments with American and Turkish tobacco are continuing.

The Director of Agriculture in Burma draws attention to the importance of the crop to Burma in the following words :— "It is probably not generally known that the average export of manufactured tobacco from Burma for the last five years has been close on 60,000 cwts.; the exports in 1911-12 being no less than 95,223 cwts. Over the last five years, the average area under tobacco has been nearly 80,000 acres." He is of opinion that the distribution of large quantities of Havana and Virginia tobacco seeds in a somewhat haphazard way, by the Agricultural Department, has had a marked effect on the tobacco supply of the Province, and he proposes to continue and to systematise this distribution.

In other Provinces there are no developments of importance to record.

(*e*) **Oil-seeds.**—Although oil-seeds form one of the most important groups of India's exports, amounting in 1912 to nearly $1\frac{1}{2}$ million tons valued at nearly £18,000,000 or about 12

per cent. of the total exports, yet, if groundnuts be excepted, comparatively little has been done by the Agricultural Department to improve them. At Pusa a study of methods of pollination—particularly of some of the oil-seed crops—which is almost a necessary preliminary to selection work, is in progress, and in many of the Provinces a certain amount of selection has been attempted, but with the exception of Messrs. Woodhouse and Taylor's work on soybeans, the results of which are being published in a memoir, hardly anything of any significance has been done hitherto on oil-seed crops other than groundnut. In the year under report, however, some progress has been made by Mr. Hector at Dacca where he has isolated the chief varieties of the genera *brassica* (rape, etc.) and *sesamum* (*til*) and is studying them in single plant cultures with a view to work on the improvement of their oil-yielding capacity.

With respect to groundnut it is not perhaps entirely an accident that the expansion of the area from under half a million acres in 1905-06 to over 1,200,000 acres in 1911-12 has coincided with the expansion of the Agricultural Department from its small beginnings in the former year to its present dimensions. In Madras, where two-thirds of the acreage is grown, marked improvement in the yield has been obtained in the past by growing cereal crops mixed with the groundnut; and an experiment made in the year under report promises a still greater improvement as a result of rotating groundnut under irrigation with Cambodia cotton.

In Bombay the area has expanded largely since the introduction of superior exotic varieties, the demand for seed of which is now greater than the market can supply in tracts where the crop has only recently been introduced. The 'tikka' disease, to which the great decline in the crop between 1894 and 1902 was due, has practically disappeared since the introduction of these new varieties.

In the Central Provinces a large area is now grown in Chhattisgarh, where it was unknown until introduced by the Agricultural Department three or four years ago, and a considerable export is anticipated.

Similarly in the United Provinces where the crop was little known till recently, it is estimated that not less than 20,000 acres of groundnuts are now grown and the profits realised are so considerable that a further rapid extension is certain. In one district seed had to be imported from Bombay to meet the demand.

In Burma the crop is firmly established and the fluctuations in area depend on the season.

(*f*) **Fibre Crops.**—There is not much to add to last year's report as to the development of fibre crops. In Bengal, Mr. Finlow has isolated one or two types of jute that are taller than most other races and produce decidedly superior fibre. A sample of *sida* having been valued at 50 per cent. more than jute fibre, at the Imperial Institute, a bale has been sent to London for sale in the open market.

In spite of the satisfactory financial results of the flax experiments at Dooriah in Bihar, which have been repeated in 1912, planters are not inclined to take up its growth and manufacture. This appears to be due to unwillingness, in view of uncertain prices, to face the risk of investing the capital necessary to establish the industry. The question of further development appears, therefore, to be purely an economic one.

Premature "poleing" or flowering of the Agave in India appears to block the way to any extension of the production of fibres of this class.

(*g*) **Rice.**—This again is a crop on which the Agricultural Department has done little work in proportion to its importance.

The work done hitherto has consisted chiefly in manurial and cultivation experiments all over India, and in the demonstration of the proved advantages of phosphatic and green manuring in most districts; of transplanting in the Central Provinces where this practice was formerly relatively rare; and of thin sowing of the seed bed, combined with single transplanting, in Madras. No definite advance has been made in principle beyond that recorded in last year's report, but the practices referred to above have been considerably extended,

and a great economic effect will undoubtedly be produced in time, particularly if prices of food-stuffs continue to rise.

The chief new developments which can now be recorded are the isolation by Mr. Hector of about 150 strains of *aman* rice, and the discovery by Dr. Butler of an eel-worm associated with, and possibly responsible for the greater part of, the disease of paddy called *Ufra* in Eastern Bengal, which is said to have caused a loss of 200,000 maunds of grain in one thana alone in 1910. For a description of the disease and of the worm, the section on Mycology, of the Pusa Institute Report, should be consulted.

(*h*) **Tea, Coffee and Rubber.**—The establishment of the Scientific Department of the Indian Tea Association has been increased by the appointment of an Entomologist and a Mycologist. The new station at Tocklai is approaching completion and the land is being laid out. Meanwhile the Mycological Section at Pusa has given all the assistance possible by the identification and investigation of fungi causing diseases in tea plants.

Experiments with coffee have been conducted by the United Planters' Association of Southern India: the most important are probably those on the hybridisation of different varieties with a view to producing disease-resistant and high-yielding strains—which have already given promising results. In this work Mr. Anstead, the Planting Expert, has secured the co-operation of the Curator of the Government Gardens, Ootacamund.

Rubber is, of course, increasing in importance, particularly in Burma; but little scientific work, if any, appears to be in progress, in spite of the prospective competition of the synthetic product.

(*i*) **Indigo.**—No developments of work on this crop from the scientific aspect have to be reported, while both the area and the price of the product have again declined.

2.—*Special Subjects.*

(*a*) **Board of Agriculture in India.**—The Seventh Meeting of the Board of Agriculture was held at Pusa on November

20th, 1911, and the following days, under the presidency of the Inspector General of Agriculture in India (now Agricultural Adviser to the Government of India). There were 13 subjects down for discussion, which were referred for consideration to Committees whose reports, with the Board's resolutions upon them, are printed *in extenso* in the published proceedings.

It was decided to hold future meetings alternately at Pusa and in the Provinces, and, provisionally, to hold the next meeting in Madras. It was also agreed that a *résumé* of each day's proceedings should be made by a member of the Board and sent to the press after approval by the Inspector General, and, the approval of Government having been obtained in advance, effect was immediately given to this resolution.

A proposal to grant honorary degrees of *Licentiate of Agriculture* was negatived.

Perhaps, the most important subject among the agenda was that of the Indian Sugar Industry which has recently been declining in the face of large importations of sugar from abroad. Resolutions were passed recommending the employment of a Sugar Engineer and the establishment of an acclimatisation and cane-breeding station in Madras. Both these resolutions have been given effect to in the year under report, as mentioned in the section on sugarcane above.

The Board also suggested that the establishment of a sugar station, to the north of the Ganges, was most desirable; and this proposition has since been favourably considered by the Government of Bihar and Orissa.

A resolution was also passed to the effect that the most important work required was the production of better canes with pure juice, and that an investigation of the constituents, other than sugar, of the Indian canes was desirable. Work on this latter question still remains to be taken up, but a further recommendation, that investigation of the Palm Sugar Industry was desirable, was suggested by Mr. Annett's work on that industry, which has since been continued and the results of which are in course of publication as a memoir.

The Board finally resolved that the subject of the Sugar Industry should come up again at the next meeting.

A resolution of the Board in favour of closer communication between the Agricultural and Co-operative Credit Departments has, perhaps, had some effect in stimulating the movement in this direction noticed in the section under " Demonstration " below.

The last subject considered by the Board was that of the maintenance of pure seed of improved varieties of crops, with respect to which the Board adopted the Committee's report, which laid down very clearly the principles on which the production and maintenance of improved seed should be carried out. The substance of this report was afterwards published in the *Agricultural Journal of India*, Vol. VII, April 1912, as an article by Mr. Howard, Chairman of the Committee.

(*b*) **Agricultural Education.**—The fact that three private students, as opposed to the stipendiary students, have attended the post-graduate courses at Pusa is of hopeful augury; 33 students attended the short practical courses.

As regards the Provincial Colleges, there is little development to report; in fact experience is showing that the courses originally prescribed are not in most cases suitable to the class of students that the Colleges are intended for.

In Bombay, indeed, the percentage of passes in the examination for the degree of Bachelor of Agriculture is high. But the question of the utility of, and demand for the course is obscured by its being made a road to a degree.

Mr. Smart, like Mr. Keatinge before him, is impressed with the fact that the College graduates on the subordinate staff have, with very few exceptions, continued to show no power to develop any original line. It almost looks as if " mere knowledge," as acquired in the assimilation in a foreign language of an advanced syllabus, really does, as the eminent physicist Professor Soddy puts it, "deaden rather than develop the intellect."

In Madras, 10 out of 12 third-year students obtained the College diploma. As regards the quality of the product, however, the Deputy Directors have noticed (in Mr. Stuart's words) " a lack of intelligent inquisitiveness and power of independent thought."

Further evidence on this point comes from the Punjab, where the Director of Agriculture says : " The verdict of the examiners is that there is too much cram and too little power of practical application. I gather that the Lyallpur students are no worse in these respects than the students of any other Indian Agricultural College, nor indeed than the students of any other Indian college in which the education has a practical side."

The division of the course into two parts and its extension to four years has been proposed, and there is no doubt that if the full course as prescribed by the Board of Agriculture is to be properly taught such an extension is absolutely necessary in every Province. The proposed preliminary two years' course at Coimbatore is to be agricultural, with lectures on popular science, but no laboratory work, and, if the agricultural quality is to be given by the use of the phenomena of agriculture as a framework for the teaching of elementary science, the experiment is likely to give very valuable results, from the point of view of rural secondary education.

The most promising line of development in connection with the colleges is perhaps to be found in the extension of practical instruction, which may vary from the mere demonstration to cultivators, on their own land, of improved practices, up to a regular course for students on the farm attached to a college.

The system of separate schools, like that at Poona, in which such practical classes are supplemented by instruction in the three R's, hygiene, and village economics, must still be regarded as on its trial so long as all the expenses, including board, are borne by Government. Two more such schools are being started in the Presidency, one of them in response to a spontaneous demand and at small expense to Government.

On the other hand, the number of students attending the short practical courses at the Poona College has increased steadily from 4 in 1909 to 15 in the year under report, all these being the sons of land-owners. No such instruction is given in connection with the Madras College.

In the Central Provinces, the simplest and shortest courses of practical instruction on the experimental farms have met

with great success, and the training of *kamdars* for the purpose of demonstrating on ryots' lands is one of the most important factors of that Department's efficiency.

At Sabour, in Bihar, a six months' practical course has been opened, and an immediate response has been made in the shape of applications for admission from the sons of genuine cultivators and zemindars.

In the United Provinces, applications have been made spontaneously by small zemindars and others for a practical training in agriculture, and to meet this demand a small number have been admitted to the Cawnpore farm.

In the Punjab, such instruction is at present limited to classes in connection with the use of reapers.

In Burma, in the absence of an Agricultural College, arrangements have been made for the training, in the vernacular, of men selected from Settlement parties for a staff of District Agriculturists. Six men have been selected as a beginning. In order to obtain lecturers for the training of these men, a six months' agricultural class has been opened, at which English-speaking Burmans are lectured on Chemistry, Botany, Entomology and Agriculture, and are given practical work. Sixteen students attended, of whom only two were required for lecturers for the District Agricultural class.

On the whole, it appears to have been proved to demonstration that the necessary foundations of agricultural as opposed to rural education in India are the improved practices evolved on experimental farms as contrasted with the teaching in colleges of relatively advanced science, which latter might well be designated as Rural University Education, and confined to the sons of the wealthiest land-owners and perhaps one or two scholarship-holders of exceptional ability.

(*c*) **Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures.**—This branch of the Agricultural Department's activity was dealt with very fully in last year's report. Progress, in the meantime, has been chiefly the normal extension of the measures there referred to, no striking developments in the means

of demonstration and distribution having been effected. There is, however, a growing recognition of the value of the co-operative movement for these purposes, and the Agricultural Department is beginning to get more and more into touch with the Co-operative Societies.

This tendency is quite in accordance with the spirit of the resolution on the subject passed by the Board of Agriculture at its meeting in November 1911, a short account of which is given above.

In Bombay, both Co-operative Societies and Agricultural Associations are of recent growth, but an attempt is being made to bring these two classes of Associations into analogous relations with the Agricultural Department.

In Madras, the Director is getting into touch with the Rural Co-operative Societies as a first step towards the reconstitution of Agricultural Associations in that Province, and has established relations with the Registrar of Co-operative Societies for the first time.

In the Central Provinces, in the words of the Director of Agriculture, " facilities for bringing the work of Co-operative Credit before the agricultural public have been immensely improved " by the addition of a section on Co-operative Credit to the *Agricultural Gazette* published by the Agricultural Department, in accordance with the policy " of regarding the Co-operative Societies as the future means through which fresh agricultural ideas will most readily reach the people." The combination of the Agricultural Associations with the Committees of the Central or District Banks has already been begun, and in Berar, where the Agricultural Department is proposing to start co-operative seed distribution unions, the Government is being pressed to push co-operative credit with a view to facilitating the work of such unions.

In the United Provinces, many of the Co-operative Societies are in close relations with the Department of Agriculture and are " beginning to find the retailing of good seed, while highly advantageous to their members, a profitable business to the Society."

As regards the Punjab, the Financial Commissioner has commented on the fact that " no allusion is made in the Director of Agriculture's report to the existence of over 650 Rural Co-operative Societies at no great distance from the Gurdaspur Station, possessed of capital and enterprise sufficient to stock improved implements for sale to their members or to purchase threshing and reaping machines to be let out on hire."

The work of demonstration and distribution can hardly be said to have been organised yet in Bengal and Bihar. Sporadic distribution of a few hundred maunds of seeds and manures and of a few implements is carried on from the central seed stores at Sibpur and Dacca and from the Experimental Farms.

In Burma, as noted in last year's report, the Director of Agriculture is now also Registrar of Co-operative Societies, but no real demonstration can be done till a staff of *District Agriculturists*, whose training has been arranged for, is available.

(*d*) **Engineering.**—The subjects of irrigation and the introduction of machinery can be conveniently included under this head, as will be seen by a perusal of the section on irrigation in last year's report. As regards irrigation, progress has consisted chiefly in the normal extension of the developments in Madras there recorded, and in the work under Mr. Musto in Bombay; these two being the only Provinces which have employed Engineers in this important branch of agricultural development.

Mr. Musto's work may be said to have consisted in the adaptation of the means of lifting water to the circumstances of each case, with a view to obtaining the efficiency that can only be ensured by such detailed adaptation. It is, perhaps, not sufficiently well understood outside the engineering profession that economic success in the use of power depends in every case on such exact adaptation of the means to the end as can only be effected with certainty and ease by a practising engineer. Time and money spent on such work by amateurs generally results merely in the belated education of the amateur.

A general idea of the questions involved is, perhaps, best conveyed by a quotation from Mr. Musto's report :—

> "I have also persuaded Messrs. Gwynne to redesign all their standard sizes of pumps with a view to obtaining a higher efficiency within the limits in which they are generally worked for irrigation pumping. They have now placed on the market, at the same price as the old type pumps, a much improved high efficiency low lift pump which is admirably suited for irrigation work on lifts up to 50 feet."

The work of the Boring Department in Bombay is about to be handed over to the Agricultural Engineer, and it is proposed to try power-driven boring plants, particularly in view of the frequent necessity, in the Presidency, of boring through rock, which cannot be managed with the Cawnpore tools.

The Agricultural Machinery Department is also under the Agricultural Engineer in Bombay. The Bajac Windlass plough has been a success, but is not considered economical for deep ploughing of black cotton soil; and steam-ploughing machinery which will plough 8 acres a day, 16 to 18 inches deep, is to be tried. The Director of Agriculture is sanguine of success and that there will be an enormous extension of the system on weed-infested land, and for sugarcane tracts. The introduction of small power-plants for crushing sugarcane has been referred to under the section devoted to that crop.

The failure to employ Engineers in other Provinces, and in other work than irrigation in Madras, is, perhaps, due to a natural but unreasonable hesitation before employing highly-paid experts. It is being realised in all directions that the substitution, for bullocks, of mechanical agencies for the control of large quantities of power, is one of the primary necessities of economic progress in a country where the population is thick and every extension of the food-producing area means a proportional reduction of that devoted to producing fodder. Thus, in Madras, the Director of Agriculture is "of opinion that in the future the Agricultural Department must pay more attention to the mechanical engineering side of agriculture,

which is getting more important every year with the rise in prices and in cost of labour and cattle."

In the United Provinces, the Director says the rise in the price of labour will force the question of power pumping for irrigation purposes to the front, and the steady stream of enquiries coming in shows that the need for a change of methods is being felt. But the post of Agricultural Engineer has been vacant throughout the year.

The Director of Agriculture in the Punjab says : "It is again necessary at the risk of wearisome repetition to point out that the efficient management of well-boring operations and the development of irrigation by tube-wells and oil-engines can never be properly carried out until a properly qualified Agricultural Engineer is appointed."

As regards recent developments outside Bombay and Madras—in the Central Provinces, an oil-engine has been set up on the Powarkhera Farm and one or two similar sets have been purchased by cultivators in the Northern Circle and are being successfully used for pumping and ginning. In the Southern Circle, 7 oil-engines and 13 gins were sold.

In the Punjab, a second and improved steam thresher has been obtained, and Messrs. Ransomes' representative will visit Lyallpur to carry out trials with it.

No developments similar to these are taking place in North-East India or in Burma.

(*e*) **Dry-Farming.**—Interesting experiments bearing on this subject have been made in Bombay. The following is a condensed account by Mr. Knight, Professor of Agriculture at Poona :—

> "A large part of the work of the year has been along this line. Extensive experiments in Ahmednagar and Akalkot were supplemented by experiments at the regular farms. The year under report was particularly favourable for such work on account of the scantiness of the rainfall.
>
> "The advantages of thorough ploughing to enable the soil to hold all the rainfall possible were again proven. Although very good results can be obtained by thorough harrowing, the advantages of thorough and frequent intertillage to prevent evaporation have been clearly proven. The crop

of Broach cotton at Poona, of 600 lbs. with a rainfall of 13·72 inches, is a sufficient proof of the possibility of retaining the moisture through frequent stirring of the soil.

"In times of scanty rainfall or in regions where insufficient moisture is the rule, the certainty of a crop can be largely insured by thinner seeding. This can be done by either sowing the rows at double the present distance, 9 inches, which facilitates the operations of intertillage, or by using only half the quantity of seed at the same distances apart as sowing is now done.

"In some 'Dry-farming regions' it is recommended that a crop should be taken on the same land only every alternate year, the field being left fallow the odd year,—the fallow to be kept throughout the year free from weeds and protected by a dust mulch. This was tried, and 770 lbs. of grain was obtained as compared to 430 lbs. of grain of last year *plus* 303 lbs. of grain of this year, thus giving 37 lbs. in favour of fallow.

"An interesting observation has been made on the College Farm bearing on the subject of holding over soil moisture in the soil from one year to another. Uniform treatment and cropping was given to an area one-half of which had been irrigated the previous year while the other half was cultivated dry, but growing the same sort of crops; those on the part that had been irrigated the previous year were able to resist the trying breaks in the unfavourable monsoon, whereas those on the adjoining area which had not been irrigated the year before succumbed to the drought or were badly injured and in the end the yield was only one-half of that of the plots of the irrigated portion.

"At Manjri attempts to reduce the water requirements of irrigagated crops by cultivation during the interval gave considerable promise."

In Mysore, early ploughing after harvest, rendered possible by the preliminary breaking up of the surface with a disc harrow, has resulted in a yield more than three times as great as that from plots ploughed only a few days before sowing. The land is kept loose after ploughing by the use of a lever harrow after rain. The ryots in the neighbourhood of the farm have recently evolved a home-made rake with iron teeth for this purpose.

(*f*) **Sericulture.**—In pursuance of the policy decided on by the Bengal Silk Committee in 1911, Mr. F. D. Lafont, an expert in the breeding of silk-worms, has been engaged for three years from January 1912 for the purpose of experimenting in hybridisation with a view to improving the quality of Bengal silk. The sale of disease-free seed from the nurseries is steadily increasing, and it is proposed to extend the system of supply to cover the whole Province. A Sericultural Class has been started, for training the sons of the professional rearers. Of six so trained, three passed the final examination and were paid a subsidy towards starting model rearing houses. In addition to this, five passed students of the Rajshahi School, started by the Diamond Jubilee Committee in 1898 and handed over to Government in 1907, received similar subsidies.

There has been no significant development in other Provinces.

At Pusa, experiments on hybridisation have been continued without any definite success. Univoltine European races have, however, been raised on all kinds of mulberries, and arrangements were made to send the eggs to the hills for preservation when the temperature at Pusa was extreme, with a view to their distribution in October. The usual distribution has been made of disease-free eggs of Eri and Mulberry silk-worms and of samples of products, information, etc.

The difficulty experienced by small rearers in marketing small quantities of Eri-silk cocoons has not been solved.

(*g*) **Poultry.**—The poultry operations conducted under the Superintendent, Lushai Hills, continue to be a success. There are five breeds distributed, *viz.*, (1) Australian Buff Orpington, (2) China Langshan, (3) Wyandottes, (4) White Orpington, and (5) Chittagong. Much good is said to have been done, not only in improving the local stock, but in fostering in the Lushais an aptitude for poultry breeding.

At Haldwani in the United Provinces, considerable progress has been made in the direction of raising a hardy stock by crossing imported with indigenous fowls.

In the Punjab the best indigenous breeds of the Province are being tried, as well as a few imported breeds, which did better than in former years.

In Sind, a white strain of Persian Gulf fowls are kept for egg production on all the Government farms, they lay well, and it is intended to try to increase this capacity by the use of trap nests. Sind game are kept for table. A fair number of turkeys have been raised and some Mammoth Bronze were obtained from Pusa. The climate is believed to be too extreme for English fowls.

PART V.

Publications and Expenditure.

Publications.—During the year 1911-12 there was a steady increase in the demand from the public in India for the *Agricultural Journal of India* and the Bulletins issued by the Imperial Department of Agriculture. The Scientific Memoirs are more in request in foreign countries. The *Journal of Tropical Veterinary Science* having been abolished, with effect from 1st April 1912, it has been decided to insert articles of a popular character on Veterinary subjects in the *Agricultural Journal of India.* A Veterinary Series has now been added to the Scientific Memoirs of this Department for the publication of papers which by reason of their being too technical are unsuited for the *Agricultural Journal.* These Veterinary Memoirs will be issued from time to time as matter becomes available. Veterinary papers which cannot suitably be included in the Journal or in the Memoirs will be published in the Bulletins of the Pusa Research Institute. These Veterinary Memoirs and Bulletins are open to all investigators in the field of Veterinary Science in India. The Editing Committee for the publications of this Department has been strengthened by the appointment of the Imperial Bacteriologist as a co-editor. The grant for publications amounted to Rs. 25,000 during this year, including Rs. 2,000 for Veterinary Memoirs. With the expansion of the work of the Department, the matter for publication is continually increasing. As noted in last year's report, the Provincial Departments are supplying an increasing volume of contributions for publication.

In Madras, 70,000 copies of the Calendar for 1911-12 were distributed and sold altogether, which indicates that it is one of the most useful means of communication between the Department and the educated ryot.

The Quarterly Journal issued by the Bengal Department of Agriculture will probably be undertaken by the Department of Agriculture, Bihar and Orissa, in future.

In the Central Provinces, the *Agricultural Gazette* continued to increase in popularity and has now 6,000 subscribers. During the year, it was enlarged by the addition of a section on Co-operative Credit and its title was changed to the *Agricultural and Co-operative Credit Gazette.* This has considerably added to its usefulness.

A complete list of the publications issued by the Imperial and Provincial Departments of Agriculture during the year is given as an appendix to this report.

Expenditure.—The expenditure incurred by the Imperial Department of Agriculture during the financial year 1911-12 amounted to Rs. 4,48,234 as follows :—

	Rs.
Inspector General of Agriculture in India	1,21,808
Imperial Cotton Specialist	22,381
Agricultural Research Institute, Pusa	3,04,045

	Rs.
Office of the Director	69,015
Chemical Section	41,012
Mycological Section	19,622
Entomological Section	37,345
Pathological Entomological Section	24,188
Botanical Section	41,542
Agricultural Bacteriological Section	22,108
Agricultural Section	49,213
	3,04,045
TOTAL	4,48,234

The above amount of Rs. 4,48,234 included expenditure under the special grant placed at the disposal of the Inspector

General of Agriculture, for such special agricultural investigations as he thinks desirable. The principal items of expenditure under this special grant were as under :—

	Rs.
(1) Contribution towards the pay of the Flax Expert engaged by the Bihar Planters' Association for 1911-12	2,750
(2) Wheat testing work done by Mr. A. E. Humphries, Weybridge, during 1911	1,500
(3) Grant-in-aid towards the purchase of a "Bajac" plough by the Director of Agriculture, Bombay	2,000
(4) Saltpetre experiments carried on by Dr. J. W. Leather at Malinagar near Pusa	3,000
(5) Poultry experiments at Pusa	3,680

The expenditure incurred by the Provincial Departments of Agriculture during the year under report was as shown below :—

	Rs.
Bengal	3,40,045
United Provinces	5,70,899
Punjab	2,79,267*
Bombay	6,32,648
Madras	3,40,645
Central Provinces	4,79,000†
Burma	1,46,400
Eastern Bengal and Assam	2,57,686

The expenditure incurred in the working of the Imperial Bacteriological Laboratory at Muktesar was as shown below :—

	Rs.
Salaries and travelling allowances of officers and establishment	86,425
Feed and keep of animals	55,842
Purchase of animals	26,166
Cost of chemicals and apparatus	10,500
Other miscellaneous expenditure	27,586
TOTAL	2,06,519

* This includes Rs. 59,594 expended on public works.

† This includes Rs. 1,98,000 spent on Veterinary Department, Nagpur Museum and Government Gardens.

Thus the total expenditure incurred both by the Imperial and Provincial Departments of Agriculture amounted during the year under report to about Rs. 34,94,824 and of the Imperial Bacteriological Laboratory at Muktesar to about Rs. 2,06,519.

APPENDIX.

List of Agricultural Publications in India during 1911-12.

No.	Title.	Author.	Where published.
	General Agriculture.		
1	The Agricultural Journal of India, Vol. VI, Parts 3 and 4, and Vol. VII, Parts 1 and 2. Price per part Rs. 2. Annual subscription Rs. 6.	Issued from the Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
2	Proceedings of the Seventh Meeting of the Board of Agriculture in India held at Pusa on 20th November 1911 and following days, with Appendices. Price 8 annas.	Ditto .	Government Printing, India, Calcutta.
3	Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for 1910-11. Price 6 annas or 7*d.*	Director, Agricultural Research Institute, Pusa.	Ditto.
4	Report on the Progress of Agriculture in India for 1910-11. Price 12 annas or 1*s.* 3*d.*	Inspector General of Agriculture in India.	Ditto.
5	Agricultural Statistics of India for the years 1905-06 to 1909-10, Vol. I. Price Rs. 2-8.	Director General of Commercial Intelligence.	Ditto.
6	Agricultural Statistics of India for the years 1905-06 to 1909-10, Vol. II. Price Re. 1.	Ditto .	Ditto.
7	Agricultural Ledger, 1911, No. 4. Vegetable Product Series, No. 115. Cinchona Bark. Price 9 annas.	Reporter on Economic Products to the Government of India.	Ditto.
8	Agricultural Ledger, 1911-12, No. 5. Oils and Fats of India. Price 8 annas.	David Hooper, F.C.S., F.L.S.	Ditto.
9	Third Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Department. Price annas 2 or 3*d.*	Report of Committee of Board of Agriculture in India, 1911.	Ditto.
10	Report on the Flax Experiments conducted at Dooriah during the year 1911-12. Bulletin No. 30 of the Agricultural Research Institute, Pusa. Price annas 1½ or 2*d.*	E. M. Vandekerkhove, Flax Expert to the Bihar Planters' Association.	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
11	The Improvement of the Yield and Quality of Wheat in India, in Hindi and Urdu.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Baptist Mission Press, Calcutta.
12	Annual Report of the Department of Agriculture, Bengal, for the year ending 30th June 1911. Price 7 annas.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
13	Annual Report of the Kalimpong Demonstration Farm for the year 1910-11. Price 4 annas.	P. W. Goodwin . .	Ditto.
14	Annual Report of the Bankipur Agricultural Station for the year 1910-11. Price 2 annas.	A. C. Dobbs, B.A. .	Ditto.
15	Annual Report of the Dumraon Agricultural Station for the year 1910-11. Price 1 anna.	Ditto .	Ditto.
16	Annual Report of the Chinsurah Agricultural Station for 1910-11. Price 6 annas.	Ditto .	Ditto.
17	Note on the Work of the Burdwan Agricultural Station for 1910-11. Price 1 anna.	Ditto .	Ditto.
18	Agricultural Statistics of Bengal for 1910-11. Price Re. 1-4.	Issued by the Department of Agriculture, Bengal.	Ditto.
19	Principles of Agriculture for Bengal. Price Rs. 3.	F. Smith, B.Sc., F.H.A.S., Deputy Director of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
20	Summary of the Methods of conducting the Agricultural Shows of Bengal. Departmental Record No. 1 of 1912. (Not for sale.)	E. J. Woodhouse, M.A., F.L.S., Principal, Agricultural College, Sabour (Bhagalpore).	Bengal Secretariat Press, Calcutta.
21	Hand-Book on Exhibitions. Departmental Record No. 2 of 1912. (Not for sale.)	Ditto .	Ditto.
22	Quarterly Journal of the Department of Agriculture, Bengal, Vol. V, Nos. 1 to 3. Price 6 annas a copy.	Issued by the Department of Agriculture, Bengal.	Ditto.
23	Rhubarb. Bulletin No. 11 of the Department of Agriculture, Bengal.	Ditto .	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
24	Asparagus. Bulletin No. 12 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
25	Season and Crop Report of Bihar and Orissa for the year 1911-12.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Ranchi.
26	Second Wage Census of Bengal taken in April 1911.	Ditto .	Ditto.
27	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1911. Price 8 annas or 9*d*.	W. H. Moreland, C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
28	Annual Report of the Aligarh Agricultural Station for the year 1910-11. Price 8 annas or 9*d*.	A. E. Parr, M.A., B.SC., PH.D., Deputy Director of Agriculture, United Provinces.	Ditto.
29	Bulletin No. 26. Description of the Working of the Sugar Factory exhibited in the Agricultural Court, United Provinces Exhibition, by Messrs. Blair Campbell and McLean.	B. C. Burt, B.SC. (London), F.C.S., Deputy Director of Agriculture, Central Circle, Cawnpore, United Provinces.	Ditto.
30	Urdu Translation of the Proceedings of the Agricultural Conference held at the United Provinces Exhibition, Allahabad, in January 1911.	Issued by the Department of Agriculture, United Provinces.	Newal Kishore Press, Lucknow.
31	Season and Crop Report of the United Provinces for 1910-11. Price 8 annas or 9*d*.	Ditto .	Government Press, United Provinces, Allahabad.
32	Report of the Government Horticultural Gardens, Lucknow, 1910-11. Price 3 annas or 3*d*.	Ditto .	Ditto.
33	Breeds of Indian Cattle, United Provinces.	E. W. Oliver, M.R.C.V.S., F.Z.S., and C. W. Wilson, M.R.C.V.S.	Ditto.
34	Annual Report on the Partabgarh Agricultural Station for the year ending 30th June 1911. Price 8 annas.	Issued by the Department of Land Records and Agriculture, United Provinces.	Ditto.
35	Note on Aligarh White-flowered Cotton, in Hindi and Urdu.	Ditto .	Standard Press, Allahabad
36	Note on American Cotton, in Hindi and Urdu.	Ditto .	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
37	Note on Sabaria Wheat, in Hindi and Urdu.	Issued by the Department of Land Records and Agriculture, United Provinces.	Government Press. Allahabad.
38	Note on Ridge Maker, in Hindi and Urdu.	Ditto .	Faize-am Press, Aligarh.
39	Note on Groundnut Cultivation, in Hindi and Urdu.	Ditto .	Ditto.
40	Note on Saretha Ukh . . .	Ditto .	Howett Press, Aligarh.
41	Note on Cultivation of Selected Deshi Cotton.	Ditto .	....
42	Note on Cultivation of American Cotton.	Ditto .	....
43	Report on the Operations of the Department of Agriculture, Punjab, for 1910-11. Price 7 annas or 7*d*.	W. S. Hamilton, I.C.S., Director of Agriculture and Industries, Punjab.	Punjab Government Press, Lahore.
44	Report on the Season and Crops of the Punjab for the year 1910-11. Price 9 annas.	Ditto .	Ditto.
	Vernacular Leaflets on—		
45	Reaping Machine . .	Issued by the Department of Agriculture, Punjab.	Ditto.
46	Winnowing Machine . .		
47	The Use of the Chain Harrow .		
48	Green Manuring . . .		
49	Furrow Turning . . .		
50	Eradication of Dub Grass .		
51	Cultivation of American Cotton		
52	Cotton Cultivation . .		
53	Maize		
54	Annual Report of the Department of Agriculture, Bombay, for 1910-11. Price 12 annas or 1*s*. 2*d*.	G. F. Keatinge, I.C.S., Director of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
55	Season and Crop Report of the Bombay Presidency for 1910-11. Price 7 annas or 8*d*.	Ditto .	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
56	Annual Report on the experimental work of the Surat Farm for 1910-11. Price Re. 1.	T. F. Main, B.SC., Deputy Director of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
57	Annual Report on the experimental work of the Dharwar Farm for 1910-11. Price Re. 1.	Ditto .	Ditto.
58	Annual Report on the experimental work of the Dhulia Farm for 1910-11. Price 14 annas or 1*s.* 4*d*	Ditto .	Ditto.
59	Annual Report on the experimental work of the Nadiad Farm for 1910-11. Price 12 annas or 1*s.* 2*d.*	Ditto .	Ditto.
60	Annual Report on the experimental work of the Dohad Farm for 1910-11. Price 12 annas or 1*s.* 2*d.*	Ditto .	Ditto.
61	Annual Report on the experimental work of the Gokak Farm for 1910-11. Price 12 annas or 1*s.* 2*d.*	Ditto .	Ditto.
62	Annual Report on the experimental work of the Mirpurkhas Farm for the year 1910-11. Price 5 annas or 6*d.*	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture.	Ditto.
63	Annual Report on the experimental work of the Manjri Farm for 1910-11. Price 4 annas or 5*d.*	J. B. Knight, M.SC., Professor of Agriculture.	Ditto.
64	Annual Report on the experimental work of the Lonavla Farm for 1910-11. Price 4 annas or 5*d.*	Ditto .	Ditto.
65	Annual Report of the Kirkee Civil Dairy Farm for 1910-11. Price 4 annas or 5*d.*	Ditto .	Ditto.
66	Annual Report on the Agricultural College Station, Poona, for 1910-11. Price 5 annas or 6*d.*	Ditto .	Ditto.
67	Annual Report on the experimental work of the Ganeshkhind Gardens. Price 4 annas or 5*d.*	W. Burns, B.SC., Economic Botanist, Bombay Presidency.	Ditto.
68	Annual Report on the Bassein Gardens. Price 4 annas or 5*d.*	Ditto .	Ditto.
69	San Hemp. Bulletin No. 47. Price 4 annas or 5*d.*	P. C. Patil, L.AG., Divisional Inspector of Agriculture, Central Division, Bombay.	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
70	Poona Furnace. Bulletin No. 48. Price 7 annas or 8*d*.	P. C. Patil, L.Ag, Divisional Inspector of Agriculture, Central Division, Bombay.	Government Central Press, Bombay.
71	An Examination of the Seed Supply of the Ahmednagar District, Part I. Price 5 annas or 6*d*.	G. D. Mehta, L.Ag., B.A., N.D.A., N.D.D., Supernumerary Agriculturist, working at Poona.	Ditto.
72	Annual Report of the Empress and the Bund Gardens, Poona, for 1910-11.	....	Arya Bhusan Press, Poona.
73	Broach Cotton. Seed Selection Series. Bulletin No. 46. Price 8 annas.	T. F. Main, B.Sc., Deputy Director of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
74	An Examination of the Seed Supply of the Ahmednagar District, Part II. Bulletin No. 50. Price 2 annas or 3*d*.	G. D. Mehta, L.Ag., B.A., N.D.A., N.D.D., Supernumerary Agriculturist.	Ditto.
75	Muscovado Sugar Machinery and its scope for *gul* manufacture in India. Price 8 annas or 9*d*.	G. N. Sahasrabudhe, L.Ag.	Ditto.
76	Leaflets with vernacular version :— No. 8 of 1911, on Iron Mhot .	Issued by the Department of Agriculture, Bombay.	Ditto.
77	No. 1 of 1912, on Treatment of a Mango Plantation.		
78	No. 2 of 1912, on how to grow Pomegranates.		
79	No. 3 of 1912, on Treatment of Grape Vine Mildew.		
80	No. 4 of 1912, on Hints on Grafting		
81	No. 5 of 1912, on Sulphate of Ammonia as a Manure for Sugarcane.		
82	No. 6 of 1912, on Cultivation of Cambodia Cotton in the Southern Maratha Country.		
83	Report on the Operations of the Department of Agriculture, Madras Presidency, for 1910-11. Price 3 annas or 3*d*.	M. E. Couchman, I.C.S., Director of Agriculture, Madras.	Government Press, Madras.
84	Season and Crop Report of the Madras Presidency for 1910-11. Price 4 annas or 6*d*.	Ditto .	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
85	Hindupur Agave Plantation. Bulletin No. 64. Price 3 pies.	G. R. Hilson, B.SC., Deputy Director of Agriculture, Madras.	Government Press, Madras.
86	The Importance of Sowing Pure Seed of Cambodia Cotton. Leaflet No. XVII, in English and Tamil.	H. Southern, B.A., Offg. Deputy Director of Agriculture, Madras.	Ditto.
87	Improvements in Paddy Cultivation recommended by the Department. Leaflet No. XVIII, in English, Tamil and Telugu.	R. Cecil Wood, B.A., Principal, Agricultural College, Coimbatore.	Ditto.
88	Cotton. Leaflet No. XIX, in English, Tamil and Telugu.	Ditto .	Ditto.
89	Sugarcane in South Canara. Leaflet No. XX, in English and Canarese.	Ditto .	Ditto.
90	Sugarcane. Leaflet No. XXI, in English, Tamil and Telugu.	Ditto .	Ditto.
91	Jaggery Making. Leaflet No. XXII, in English, Tamil, Telugu, Malayalum and Canarese.	M. R. Ry. D. Bala Krishna Murti.	Ditto.
92	Ginger Cultivation on the West Coast. Leaflet No. XXIII, in English, Malayalum and Canarese.	M. R. Ry. M. Govind Kistvu.	Ditto.
93	Agricultural Calendar for 1912-13, in English, Tamil, Telugu, Malayalum and Canarese.	Department of Agriculture, Madras.	Ditto.
94	Agricultural College, Coimbatore. Leaflet No. II of 1912.	R. Cecil Wood, B.A., Principal, Agricultural College, Coimbatore.	Ditto.
95	Report on the Working of the Department of Agriculture, Central Provinces, for the year 1910-11. Price Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
96	Report on the Agricultural Stations in the Central Provinces and Berar for the year 1910-11. Price Re. 1.	Ditto .	Ditto.
97	Report on the Management of the Provincial and District Gardens, Central Provinces, for the year 1910-11. Price 8 annas.	Ditto .	Ditto.
98	The Agricultural and Co-operative Gazette, monthly publication, August 1911 to June 1912. Price 2 annas per copy.	Ditto .	Printed at the Desh-Sewak Press, Nagpur.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
99	Report on the Operations of the Department of Agriculture, Burma, for 1910-11. Price 6 annas or 7*d*.	H. Clayton, M.A., I.C.S., Director of Agriculture, Burma.	Government Printing, Burma, Rangoon.
100	Scientific Report of the Mandalay Agricultural Station for the year 1910-11. Price 4 annas or 5*d*.	E. Thompstone, B.SC., Deputy Director of Agriculture, Burma, Northern Circle.	Ditto.
101	Rural Development in Burma. Price Re. 1.	H. Clayton, M.A., I.C.S., Director of Agriculture, Burma.	British Burma Press, Rangoon.
102	Two useful Rice Pounders used in the Shan States. Leaflet No. XXVIII.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
103	Cultivation of the Castor Oil Plant. Leaflet No. XXIX.	Ditto .	Ditto.
104	List of Improvements recommended by the Department.	Ditto .	Ditto.
105	Report of the First Agricultural and Co-operative Conference, Burma, held from July 18th to 21st, 1911.	Ditto .	Ditto.
106	What Kind of Paddy to grow and how to obtain pure seed. Cultivators' Leaflet No. 31.	Ditto .	Government Central Press, Rangoon.
107	Para Rubber. Cultivators' Leaflet No. 36 (in Burmese).	Ditto .	Ditto.
108	Annual Report of the Agricultural Department of Eastern Bengal and Assam for the year ending 30th June 1911. Price 8 annas.	Issued by the Department of Agriculture, Eastern Bengal and Assam.	Government Secretariat Press, Shillong.
109	Annual Report of the Dacca Agricultural Station for the year ending 30th June 1911.	Ditto .	Ditto.
110	Annual Report of the Burirhat Agricultural Station for the year ending 30th June 1911.	Ditto .	Ditto.
111	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1911.	Ditto .	Ditto.
112	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1911.	Ditto .	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
113	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June 1911.	Issued by the Department of Agriculture, Eastern Bengal and Assam.	Government Secretariat Press, Shillong.
114	Annual Report of the Fruit Experimental Station, Shillong, for the year ending 30th June 1911.	Ditto .	Ditto.
115	Annual Report of the Tropical Plantation at Wahjain for the year ending 30th June 1911.	Ditto .	Ditto.
116	Central Seed Depôt, Dacca. Price List, 1911-12.	Ditto .	Ditto.
117	Annual Report of the Agricultural Stations in Eastern Bengal and Assam for the year 1910-11. Price 12 annas or 1*s.*	Ditto .	Ditto.
118	Indian Tea Association, Scientific Department, Quarterly Journal, Part IV, 1911. Parts I—II, 1912.	Issued by the Scientific Department, Indian Tea Association.	Catholic Orphan Press, Calcutta.
119	Green Manuring in Mysore. Bulletin No. 1. Price annas 8.	Issued by the Mysore Department of Agriculture.	Government Press, Bangalore.
120	A Kannada leaflet on the Cultivation of Broach and Cambodia Cotton.	Ditto .	Ditto.
121	Soils—A paper read before the South Indian Association.	S. Narayan Swami Iyer, M.A.	Bangalore Daily Post, Ltd., Bangalore.
122	Report of the Sixth Indian Industrial Conference held at Allahabad on 30th December 1910. Price Rs. 2. (Postage extra.)	The General Secretary, Indian Industrial Conference, Amraoti, Central Provinces.	Messrs. G. C. Loganadham Bros., Mount Road, Madras.
123	Report of the Indigo Research Station, Sirsiah, for the year 1911-12.	Cyril Bergtheil, Scientific Officer to the Bihar Planters' Association.	Baptist Mission Press, Calcutta.
124	Rural Economy in the Bombay Deccan. Price 4*s.* 6*d.*	G. F. Keatinge, I.C.S., Director of Agriculture, Bombay.	Longmans, Green & Co., Bombay.
125	Experiments on Paddy Cultivation during the years 1909-11. Bulletin No. 2, General Series, Department of Agriculture, Mysore State. Price 8 annas.	L. C. Coleman, M.A., Ph.D., and D. G. Ramchandra Rao.	Mysore Government Press, Bangalore.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	Agricultural Chemistry.		
126	Records of Drainage in India. Memoirs of the Imperial Department of Agriculture, Chemical Series, Vol. II, No. 2. Price Re. 1.	J. Walter Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist.	Messrs. Thacker, Spink & Co., Calcutta.
127	The *Rab* System of Rice Cultivation in Western India. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. II, No. 3. Price Re. 1.	H. H. Mann, D.SC., Agricultural Chemist to the Government of Bombay; N. V Joshi, B.A., B.SC., L.AG.; and N. V. Kanitkar, B.AG.	Ditto.
128	Experiments at the Partabgarh Experimental Station, 1909-11. Bulletin No. 27 of Agricultural Research Institute, Pusa. Price 5 annas or 6*d*.	G. Clarke, F.I.C.; H. E. Annett, B.SC., M.S.E.A.C.; Syed Zamin Hussain, B.A.; assisted by S. C. Banerji and Naib Hussain.	Government Printing, India, Calcutta.
129	Report on the Sugar Cultivation in the Mohnyin Valley, Katha District.	F. J. Warth, M.SC., Agricultural Chemist, Burma.	Superintendent, Government Printing, Burma.
130	Report on the Source, Supply and Agricultural Value of Silt in Burma.	Ditto .	Ditto.
131	Sugarcane in Burma. Bulletin No. 6. Price 2 annas or 2*d*.	J. MacKenna, M.A., I.C.S., Director of Agriculture, and F. J. Warth, Agricultural Chemist, Burma.	Ditto.
132	Note on the Available Manures in Burma.	F. J. Warth, M.SC., Agricultural Chemist, Burma.	Ditto.
133	Principles of Paddy Manuring. Bulletin, Vol. III, No. 63.	W. H. Harrison, M.SC., Agricultural Chemist, Madras.	Government Press, Madras.
134	Paddy Manuring. Leaflet No. 24, in Tamil and Telugu.	Ditto .	Ditto.
135	Notes on Manures. Bulletin No. 1. Price 2 annas.	A. A. Meggitt, B.SC., Agricultural Chemist to the Government of Bengal.	Bengal Secretariat Book Depôt, Calcutta.
136	Indigenous Manures of Southern India and their application. Bulletin No. 65.	W. H. Harrison, M.SC., Government Agricultural Chemist, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	Agricultural Chemistry—contd.		
137	The Methods of Reclaiming Saline Soils, in English, Tamil and Telugu.	W. H. Harrison, M.Sc., Government Agricultural Chemist, Madras.	Government Press, Madras.
	Mycology.		
138	Preliminary Study of the Red Rot of Sugarcane in the Bombay Presidency. Bulletin No. 44. Price 8 annas or 9*d.*	G. S. Kulkerni, L.Ag., Assistant Mycologist, Agricultural College, Poona.	Government Central Press, Bombay.
139	Two Years' Experiments in the Treatment of Grape Vine Mildew in the Bombay Presidency. Bulletin No. 45. Price 14 annas or 1*s.* 4*d.*	W. Burns, B.Sc., Economic Botanist, Bombay Presidency.	Ditto.
140	Ufra Disease of Rice. Bulletin No. 2 of 1912. Price 6 pies.	G. P. Hector, M.A., B.Sc., Economic Botanist to the Government of Bengal.	Bengal Secretariat Book Depôt, Calcutta.
141	Third Year's Experiments in the Treatment of Grape Vine Mildew in the Bombay Presidency. Bulletin No. 51. Price 3 annas or 3*d.*	W. Burns, B.Sc., Economic Botanist, Bombay, and G. B. Patwardhan, Assistant to the Economic Botanist.	Government Central Press, Bombay.
	Botany.		
142	Studies in Indian Fibre Plants: No. 2. On some new varieties of *Hibiscus cannabinus* L. and *Hibiscus sabdariffa* L. Memoirs of the Imperial Department of Agriculture, Botanical Series, Vol. IV, No. 2. Price Rs. 3.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.
143	Notes on the Incidence and Effect of Sterility and Cross-fertilization in the Indian Cottons. Memoirs of the Imperial Department of Agriculture, Botanical Series, Vol. IV, No. 3. Price Re. 1.	H. M. Leake, M.A., F.L.S., Economic Botanist, United Provinces, and Ram Prasad, Assistant to the Economic Botanist, United Provinces.	Ditto.
144	Note on the Inheritance of Red Colour and the Regularity of Self-fertilization in *Corchorus capsularis*, the common Jute Plant. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. IV, No. 4. Price Re. 1.	I. H. Burkill, M.A., Economic Botanist to the Botanical Survey of India, and R. S. Finlow, B.Sc., F.C.S., Fibre Expert to the Government of Bengal.	Ditto.

List of Agricultural Publications in India during 1911-12—contd.

No.	Title.	Author.	Where published.
	Botany—contd.		
145	Observations on certain Extra-Indian Asiatic Cottons. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. IV, No. 5. Price Re. 1-8-0.	H. Martin Leake, M.A., F.L.S., Economic Botanist, United Provinces, and Ram Prasad, Assistant to the Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.
146	The Cultivation of the Para Rubber Tree. Price 2 annas or 2*d*.	A. M. Sawyer, Assistant Botanist, Burma.	Government Printing, Burma, Rangoon.
	Entomology.		
147	Life Histories of Indian Insects, III, The Rhinoceros Beetle (*Oryctes Rhinoceros*) and the Red or Palm Weevil (*Rhynochophorus ferrugineus*). Memoirs of the Imperial Department of Agriculture, Entomological Series, Vol. II, No. 10. Price Rs. 2.	C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Messrs. Thacker, Spink & Co., Calcutta.
148	The Food of Birds in India. Memoirs of the Imperial Department of Agriculture, Entomological Series, Vol. III. Price Rs. 7-8.	C. W. Mason, late Supernumerary Entomologist.	Ditto.
149	Note on the Silk-worm rearing in the Punjab. Bulletin No. 3 of 1910 (1912 issue).	Issued by the Department of Agriculture, Punjab.	Punjab Government Press, Lahore.
150	Brief Instructions for the Rearers of Silk-worm.	Ditto	....
151	Leaflet in Bengali on the rice ear cutting Caterpillar (*Chheni Poka* or *Leda Poka*).	Issued by the Department of Agriculture, Bengal.	....
152	*Koleroga* of Supari, a pamphlet in Kanada containing full instructions for spraying and preparing spraying solutions (intended for local distribution).	Issued by the Department of Agriculture, Mysore.	....
153	Eri Silk. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. IV, No. 1. Price Rs. 3.	H. Maxwell-Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist, and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1911-12—concld.

No.	Title.	Author.	Where published.
	Entomology—contd.		
154	Damage by Beetles in Tea Chest Woods. Price 6 annas.	G. D. Hope, PH.D., and C. B. Antram.	Catholic Orphan Press, Calcutta.
155	Potato Moth. Leaflet No. 1 of 1912 .	E. J. Woodhouse, M.A., F.L.S., Principal of the Agricultural College, Sabour.	Bengal Secretariat Press, Calcutta.
156	The Pests of San Hemp and how to check them. Leaflet No. 2 of 1912.	P. C. Sen, Entomological Assistant.	Ditto.
157	Deccan Grass-hopper Pest. Leaflet No. 3 of 1912.	T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Government Entomologist, Madras.	Government Central Press, Madras.
158	The Common Hairy Caterpillar, Burmese "Ku." Cultivators' Leaflet No. 32.	Issued by the Department of Agriculture, Burma.	Government Central Press, Rangoon.
159	Fruit Flies. Cultivators' Leaflet No. 33.	Ditto .	Ditto.
160	The Spotted Bollworm. Cultivators' Leaflet No. 34.	Ditto .	Ditto.
161	The Brown Coccid (*Ceroccus Hibisci* Green). Leaflet No. 35.	Ditto .	Ditto.
162	Field Crickets (Burmese Payit). Leaflet No. 37.	Ditto .	Ditto.
163	The Moth of Sugarcane and Jowar (Pamphlet).	Issued by the Department of Agriculture, United Provinces.	....
164	Kumblihulas attacking Crops in Mysore (*Amsacta albistriga* Wlk.). A Preliminary Report, Department of Agriculture, Mysore State, Entomological Series, Bulletin No. 3. Price 8 annas.	L. C. Coleman, M.A., PH.D., Mycologist and Entomologist to the Government of Mysore.	Mysore Government Press, Bangalore.
	Veterinary.		
165	Note on Surra. Bulletin No. 27 of the United Provinces Department of Agriculture.	Issued by the United Provinces Department of Agriculture.	....
166	Journal of Tropical Veterinary Science, Vol. VII, Part 1, January 1912. Price Rs. 4.	Issued by the Imperial Civil Veterinary Department.	Thacker, Spink & Co., Calcutta.

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TABLE OF CONTENTS

	Page
Introductory	1
Part I.—The Imperial Department of Agriculture in India—	
1. Office of the Agricultural Adviser to the Government of India	7
2. Tours	7
3. Agricultural Research Institute, Pusa	8
(*a*) Training	8
(*b*) Agriculture	9
(*c*) Chemistry	9
(*d*) Botany	10
(*e*) Mycology	11
(*f*) Entomology	12
(*g*) Pathological Entomology	12
(*h*) Agricultural Bacteriology	13
Part II.—Progress in the Provinces—	
1. Bombay	16
2. Madras	17
3. Central Provinces	18
4. Bengal	20
5. Bihar and Orissa	21
6. Assam	22
7. United Provinces	23
8. Punjab	24
9. North-West Frontier Province	25
10. Burma	26
11. Mysore	27
12. Travancore	27
13. Baroda	28
14. Kashmir	29
Part III.—Progress in Veterinary Work	30
Part IV.—Crops and Special Subjects—	
1. Crops	33
(*a*) Rice	33
(*b*) Cotton	36
(*c*) Wheat	42

PAGE.

(*d*) Tobacco 44
(*e*) Sugarcane 45
(*f*) Oil-seeds 49
(*g*) Tea, Coffee and Rubber 51
(*h*) Indigo 52
(*i*) Fruit 53
2. Special Subjects 55
(*a*) Agricultural Education 55
(*b*) Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures . . 58
(*c*) Agricultural Engineering 63
(*d*) Dry-farming 66
(*e*) Sericulture 67
(*f*) Board of Agriculture in India 69
(*g*) Co-operation 70

PART V.—PUBLICATIONS AND EXPENDITURE—
(1) Publications 76
(2) Expenditure 78

APPENDIX.—LIST OF AGRICULTURAL PUBLICATIONS IN INDIA DURING 1913-14 81

THE RIGHT HON. EARL CURZON OF KEDLESTON.

Founder of the Agricultural Research Institute and College, Pusa.

REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1913-14

INTRODUCTORY.

The Imperial Agricultural Research Institute and College at Pusa.—The Pusa Institute has completed the tenth year of its existence and as being the headquarters of the Imperial Department of Agriculture it will not be out of place to give a brief retrospect of its history. The post of the Inspector-General of Agriculture in India was created in 1901 to which were attached an Agricultural Chemist and Cryptogamic Botanist and later in 1903 an Entomologist. While the Inspector-General of Agriculture's headquarters were at Nagpur, the Chemist and Botanist lived at Dehra Dun and the Entomologist at Surat. It was in 1904 that the Government of Lord Curzon determined to reorganize the department and establish it on modern lines. A short time before this, owing to the decline of the indigo industry in Bihar the planters were endeavouring to improve their agricultural methods and scientific officers had been engaged to that end. The efforts of the planters and mercantile community in Calcutta interested in indigo, were generously supported by grants-in-aid from the Local Government. But it soon became apparent that the investigations which included work on Indian crops in general concerned not only the indigo planter of Bihar but the Indian cultivator as well. The success of the work of the scientific officers at the Dalsing Serai

Experiment Station opened the eyes of Government to the improvements which were possible in Indian agriculture, and to the fact that the country lacked an adequate organization to cope with agricultural investigations on modern lines. In 1904 the work at Dalsing Serai as a private enterprise was closed and was transferred by Government to Pusa which henceforth became the headquarters of the Imperial Department of Agriculture for India. A Director was appointed, the scientific officers already in the country were located there and others were brought out from home to fill posts dealing with the various branches of agricultural science and practice. It was thus that Lord Curzon ably supported by Sir Edward Law, Member for Finance, and Sir Denzil Ibbetson, the Revenue Member, commenced his policy for the amelioration of the agricultural industry and laid the foundations of the Indian Agricultural Department as at present constituted. About the same time an American citizen Mr. Henry Phipps presented Lord Curzon with a donation of £30,000 to be devoted to some object of public utility, preferably in the direction of scientific research and the amount was utilized for the building of the Imperial Agricultural Research Institute and College at Pusa. The Institute is located on an estate of 1,358 acres. There is a farm of over 500 acres under arable and some 200 acres in grass for cattle-breeding. The work of the Institute and College is apportioned under the following sections:— (1) General Administration, (2) College, (3) Farm, (4) Chemistry, (5) Botany and Plant Improvement, (6) Bacteriology, (7) Plant Pathology, (8) Entomology, (9) Pathological Entomology. Officers of matured experience have been appointed to the various divisions, as well as Supernumerary Officers to act as assistants and as a leave reserve. A higher and lower subordinate staff has also been appointed numbering 112. To the above should be added the post and office of the Imperial Cotton Specialist at Kirkee and the Imperial Bacteriological Laboratories for veterinary research at Muktesar, for although not located at Pusa the control of their work has been brought under the Imperial Department of Agriculture and has added to the work and responsibilities of Pusa. At Muktesar where research is carried

on into the diseases of cattle, and sera and vaccines are manufactured on a large scale, the staff has been recently strengthened and now consists of a Bacteriologist, Assistant Bacteriologist, Pathologist and Physiological Chemist with the necessary understaff.

Under the original scheme, Pusa was to be the only agricultural station of its kind in India and students from the provinces were to be sent there for a general course in agricultural science and practice. This arrangement was subsequently modified and a policy of expansion was adopted under which local departments of agriculture were set up in each of the provinces, to six of which agricultural colleges were attached. The duty of teaching was thus relegated chiefly to these colleges. Pusa henceforth devoted its attention principally to research but it was also required to give a post-graduate course of training in special subjects such as chemistry, botany, mycology, entomology, bacteriology and the like to distinguished students and it further undertook to give instruction in short practical courses in agriculture, fruit, silk, lac, cattle-breeding, etc. This change of policy was certainly an improvement, for it provided not only a means for the adequate investigation of provincial problems but it freed the staff at Pusa from much routine teaching and enabled it to devote its attention principally to research. The change did not take place, however, without its being subjected to severe criticism which has not altogether died out. Many people thought and apparently still think that Pusa had sacrificed much of its influence and usefulness in surrendering its teaching of a general course in favour of research. This was because the position was not understood. The great importance of research in unravelling the principles underlying agricultural practice and crop production and for improving the imperfect methods and material, was not realized. From the point of view of direct benefit to the agricultural industry and to the masses dependent on it, experiment directed to the expansion of agricultural production is of greater importance than teaching. A little thought moreover would have convinced anyone that research must precede knowledge of the subject and that it was quite impossible for any considerable improvement to take place

unless the undisturbed attention of the scientific officers was devoted to research. It is extremely difficult to combine the duties of teaching and research in one officer. The change undoubtedly has led to favourable results as it has enabled Pusa to take up the position of a Central Research Institute for the whole of India and has placed the staff in a position which enables them to give their undivided attention to important investigations and provides means for acquiring that knowledge which is a condition precedent to training others and to the application of remedial measures. In spite, however, of the restrictions thus imposed in the matter of teaching the Pusa Institute has passed out 229 students under various heads including post-graduate courses, training probationers for special posts in the Provincial Agricultural Departments, giving short courses in fruit, cattle-breeding, lac, sericulture and training casual students who worked in the laboratories.

An idea of the work performed by the Institute may be partially gathered from the scientific publications that have issued under the various branches of science :—Chemical Memoirs 24, Botanical Memoirs 39, Entomological Memoirs 24, Bacteriological Memoirs 2 and Veterinary Memoirs 8, or a total of 97. Besides this, 48 Bulletins and pamphlets some of which are in the vernacular on various subjects have issued from the Institute as well as books. These publications are not all the work of officers of the Institute but a very large majority are. A popular Journal of Agriculture is also published every quarter. The exchange in publications is considerable and the Institute corresponds with some 150 to 200 learned societies at home and abroad most of which exchange publications. There is a library containing the best and latest literature on agricultural science and practice numbering twenty-one thousand volumes. It is available for workers in the provinces as well as at Pusa.

Among the more important works performed by the Institute may be mentioned the preparation of an account of the wheats of India and the working out of the inheritance of the varietal characters of Indian wheats on Mendelian lines and of the influence of the environment on milling and baking qualities, resulting in discoveries of great significance in connection with

this staple which have laid the foundations for the improvement of this important crop throughout India; the establishment of the economic significance of natural cross-fertilization amongst cultivated crops showing the importance of adequate control being brought to bear upon the improvement of the plant and on the methods used in the growth and distribution of the seed of improved varieties of crops; experiments on the availability of phosphates and potash in Indian soils, the loss of water from soil during the dry weather, the water requirements of crops, records of the constituents of drainage water; the preparation of an account of the insect pests of India, an account of the locust problem in the Bombay Presidency; investigations on the more important crop-pests and the working out of remedies; investigations into the important subject of soil bacteriology and the working out of the role played by bacteria in the fertilization of Indian soils; the study of crop diseases from every part of India and the application of remedial measures, prominent amongst which is the work on the disease of the palmyra palm which in the Godavari delta of the Madras Presidency has saved a time honoured industry from extinction; investigations into the saltpetre industry; studies of the various types of India tobaccos and the critical examination of various Indian crops such as gram, rape, mustard, pigeon-pea, fibre plants, etc.; the study of the effects of improved cultivation and of the use of improved implements; the establishment and improvement of one of the best breeds of Indian cattle; the publication and dissemination of the results of important work and a large amount of correspondence with persons in India and all over the world entailed by the fact that Pusa has become the Central Bureau of information on Indian agricultural matters. To the above should be added the important work performed in the veterinary laboratories at Muktesar where research is carried on in the diseases of cattle and prophylactic and curative sera and vaccines are manufactured on a large scale to deal with the epidemics of cattle diseases on the plains. This gives but a meagre description of the work and activities of the Institute during the first ten years of its existence and space does not permit of enlarging on it. It may, however, be remarked in

conclusion that while it takes time for an institution like that at Pusa to establish its position among learned institutions, some of its workers have already attained a world wide reputation and there is reason to expect that as time goes on its influence as a seat of learning may still further be strengthened.

A portrait of Lord Curzon is attached as he is the founder of the Imperial Agricultural Research Institute and College of Pusa and created the Indian Agricultural Department as at present constituted. He likewise initiated the co-operative movement which is now joining with the agricultural department in the spread of improvements and I venture to think that the combination of these two forces will not be surpassed in affording for this country potent means for increasing the welfare and happiness of the vast majority of the people.

BERNARD COVENTRY,
Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa.

PUSA;
The 15th January 1915.

PART I.

The Imperial Department of Agriculture in India.

1. *Office of the Agricultural Adviser to the Government of India.*—Mr. J. Mackenna, M.A., I.C.S., held charge of the office of the Agricultural Adviser to the Government of India from 6th March 1913 till the return of Mr. Bernard Coventry, C.I.E., from leave on the 23rd February 1914. Mr. A. C. Dobbs, B.A., held the post of Assistant to the Agricultural Adviser to the Government of India up to 28th April 1914, from which date he has been officiating in the post of the Imperial Agriculturist in place of Mr. Milligan on leave and Mr. Wynne Sayer, B.A., was appointed to act for him.

2. *Tours.*—During the year under report much of the time of the Agricultural Adviser was, as usual, spent on tour. In August and September 1913, Mr. Mackenna undertook an extensive tour, and visited Dacca where he inspected the farm and the laboratories and conferred with the officers of the Bengal Department of Agriculture. He then toured through the province of Bihar and Orissa and inspected the Agricultural College and the Farm at Sabour and the experiment station at Bankipur and also proceeded to Sipaya to inspect the site selected for the cattle-breeding station which was then under contemplation. The tour in this province was completed with a visit to Ranchi where Mr. Mackenna conferred with the Local Government. The Central Provinces were next visited for an inspection of the Agricultural College and the Farm at Nagpur, and the Farm at Akola. In the beginning of September he went to Poona where he inspected the Agricultural College and conferred with the Local Government and the Director of Agriculture of the Province. During this month he also visited the Imperial Bacteriological Laboratory at Muktesar. In November 1913, he went to Delhi to give evidence before the Royal Commission on Public Services in India and took the opportunity of visiting Cawnpur and Lucknow. In

December Mr. Mackenna presided at the meeting of the Board of Agriculture held at Coimbatore. During his stay there he paid a short visit to Ootacamund to see the hybridization station of the United Planters' Association of Southern India. Mr. Mackenna, having been appointed additional member of the Legislative Council of the Governor General, attended a session of the Council at Delhi in January 1914, when the bill for the prevention of the introduction of destructive insects and pests was introduced into the Imperial Legislative Council. During this month he visited Muzafferpur twice to see the local agricultural exhibition and to attend the meeting of the Bihar Planters' Association. In February he went to Calcutta to confer with the local officers on the question of extension of jute cultivation in Bengal.

On his return from leave Mr. Coventry toured in Bihar in March 1914, with Mr. Peter Abel of the Harvey Engineering Co., Ltd., Glasgow, and visited the sugar factories at Japaha, Barrah, Pursa, Saraha and other places. During this tour he also visited the sugarcane experiment station at Sipaya. In April 1914, he went to Bareilly to inspect the Branch of the Imperial Bacteriological Laboratory. He attended the meeting of the Board of Scientific Advice held at Simla on 18th May 1914. May and June were spent in Simla.

3. *Agricultural Research Institute, Pusa.*—A detailed account of the work done in the various sections of the Institute during the year is given in the Annual Report of the Institute, so that it is only necessary here to mention some of the more salient features of the year's work.

(*a*) **Training.**—Four graduate students were under training in Agricultural Chemistry, one in Agricultural Bacteriology, one in Agriculture, while two in Entomology completed their courses. One student attended the short course in cattle management and six in sericulture. The training in post-graduate courses at Pusa has been confined mostly to the requirements of the Provincial Departments of Agriculture. There is little hope of attracting students in any considerable number for higher agricultural education until the experimental and district work of the local Agricultural Departments has more

widely developed. This fact was recognized by the Board of Agriculture, 1913, in connection with the subject of Agricultural Education. A full account of the discussions of the Board of Agriculture in this connection is given in the section devoted to Agricultural Education in this report.

It is satisfactory to note that the facilities afforded in the Phipps' Laboratories for scientific work are taken advantage of by experts of other departments and associations, three of whom worked for some time in the laboratories during the year under report.

(*b*) **Agriculture.**—The chief subjects to which attention is being devoted in this branch are farm economics and engineering. The gross receipts during the year from the sale of farm produce, milk and other miscellaneous articles amounted to Rs. 22,157 as against Rs. 14,663 of the preceding year. Steam tackle has been introduced with which it is hoped to bring about an improvement in cultivation and deal more effectively with labour difficulties.

An Ayrshire bull has been obtained to cross with the Montgomery cows with a view to studying the inheritance of the more important characters of dairy cattle and improve their milking powers. This cross has been demonstrated by Military Dairies in Northern India to be an exceedingly useful one, the yield of milk having been doubled. Henceforth there will be maintained at Pusa two herds, one of selected milkers of Montgomery breed and the other Ayrshire-Montgomerys, which will take their part in a comprehensive scheme now under consideration for improving the dairy cattle of India.

(*c*) **Chemistry.**—Mr. Leather's work on sugar at the Tarnab Farm reveals the capabilities of the Peshawar Valley for the production of sugar. It has been ascertained that sugarcane can be preserved in *clamps* over the months of February and March and that sugar beets of good manufacturing quality can be grown to perfection so as to supply a factory from the middle of March until the end of June.

The investigations into the relationship between the amount of gaseous carbonic acid in soils and the amounts of lime and magnesia in solution have shown that if magnesium carbonate

is added in any material quantity to agricultural land, it may readily cause an almost entire precipitation of carbonate and hence render the soil unfertile. Details of these investigations are published in Chemical Memoir, Vol. III, No. 8.

The results of Mr. Leather's work on the yield and quality of milk of the Montgomery herd at Pusa and the numerical value of the errors accompanying milk tests have been published in this Department's Memoir, Vol. III, No. 6, Chemical Series. The data obtained showed that the yield of milk of most of the cows lay between 10 and 14 lbs. a day and that there was little difference in the yield from two sides of the udder or of the morning and evening milk, although in point of fat percentage, the morning milk was always richer. The mean percentage of fat in the milk of individuals varied from 3·5 to 5·0. The probable error of a single milking was about $\pm 0{\cdot}28$, but when the calf was allowed as little as possible the probable error rose to about three times as great.

(*d*) **Botany.**—The work of this section comprises the improvement of some of the more important staples.

Wheat, tobacco, and indigo are dealt with under the sections devoted to these crops in this report. Work on other crops such as gram, fibre plants and oil seeds in the way of selection and the study of methods of pollination has been continued.

The outstanding feature of the work on wheat of the year under report has been the further confirmation of the fact that one of the wheats (No. 12) gives exceedingly good results whether grown by cultivators in the Gangetic plain or on the black soils of Peninsular India. It has proved to be the best wheat for general cultivation. With regard to distribution, steps have been taken to grow this wheat on a large scale on seed farms near Pusa under the supervision of the Imperial Economic Botanist. In the central circle of the United Provinces it is proposed with the help of Co-operative Societies to systematically replace country wheats by Pusa 12 and a beginning has already been made during the present year in growing sufficient seed at a few centres so that the surplus, if any, can be sent to England for the purpose of introducing the wheat on the Home markets.

The results of investigations into the diseased condition of Java Indigo have been most important in that they indicate the line of arresting the decline of this crop and of rehabilitating the indigo industry. The results together with other aspects of the improvement of indigo in Bihar have been published in a report to the Bihar Planters' Association.

The experiments on surface drainage, an account of which has appeared in the *Agricultural Journal of India*, Vol. IX, Part II, have given results of far-reaching effects in improving the crop-producing power of soils in Bihar.

Work at Quetta relating to the development of the fruit industry in Baluchistan continues and progress has been made in the laying out and equipment of an Experiment Fruit Station.

(*e*) **Mycology.**—The serious disease of paddy which is known in Eastern Bengal as *Ufra* engaged a large part of the attention of the Mycological Section during the year. The enquiry has confirmed the theory that the organism responsible for the damage is a form of eel-worm belonging to the genus *Tylenchus*. The losses caused by *Ufra* are very heavy, in some instances as much as half the crop being destroyed. Further work is in progress with a view to working out the life-history of the organism and testing methods for its control. Experiments in remedial measures also are in progress at Comilla.

The results of the investigation of the fungus diseases of sugarcane have been published in two Memoirs issued during the year. These deal with the methods of infection and control in the red rot of sugarcane, and with the symptoms and cause of three (up till now) undescribed cane diseases.

Other important diseases under investigation during the year were cotton and sesamum wilts, and potato blight. Interesting observations have been made in the case of cotton wilt, which has been found to be due to a species of *Fusarium*. Considerable differences have been observed between the Indian cotton wilt fungus and the organism which is the cause of cotton wilt in America. It has also been found that the variety named *buri* is absolutely immune from the disease.

Numerous other diseases, *viz.*, Palm diseases, Rhizoctonia, Potato Blight, Anthracnose on betel, plantain, chilli and papaya and groundnut disease have been studied and described and the usual systematic work has been continued. Investigation on phanerogamic parasites was resumed.

(*f*) **Entomology.**—In this section investigation into the life-histories of injurious and other insects was continued and complete life-cycles of many insects were obtained. Special atttention was paid to the crop pests of wheat, rice, sugarcane and cotton and of stored grain.

Information is being collected on the subject of the natural enemies of crop pests, which is of great practical importance in India and special attention has been paid to the parasites and hyperparasites of the cotton bollworm.

The investigations on silk continue to form an important part of the work of this section at Pusa. Indian varieties of silkworm are being crossed with foreign breeds. A multivoltine cross was established after many trials and this at first yielded silk superior in quality and quantity to those of the Bengal multivoltine races, but the strain deteriorated till there was practically no difference between the cross and the Bengal races. Experiments are being continued to try and establish a stable race.

Work in lac culture and experiments in bee-keeping have been continued and new insecticides and insecticidal methods tested as occasion arose.

An event of the year which deserves mention in this report is the passing of the Destructive Insects and Pests Act for controlling the importation into British India of living plants which might otherwise in the future bring in noxious insects as they have done in the past.

(*g*) **Pathological Entomology.**—Mr. Howlett's attention was chiefly devoted to an attempt to work out methods of insect-control by examining and taking advantage of the reactions of insects to particular stimuli which seem to influence to a very large extent their more important activities—an enquiry which bids fair to give results by which considerable improvement in the present methods of insect control may be effected.

On the veterinary side, work on the bionomics of flies likely to be surra carriers has been continued, and investigations on the habits and life-history of lice are being made.

Life-histories of two new species of fruit flies have been worked out and a series of life-history memoirs of all the common species is in the course of preparation.

(*h*) **Agricultural Bacteriology.**—The principal subject upon which work has been done in this section both in the field and the laboratory during the year under report has been the use of green manuring, with special reference to the addition of nitrogen to the soil by this means and the availability or otherwise of this element when so added. The conditions under which nitrification takes place in soil have naturally formed an important part of the work and it has been found in connection with numerous experiments made to determine the optimum moisture content for nitrification in various soils that not only is the quantity of water all important but to obtain the maximum of nitrification it must also be fully realised in the treatment, that ammonification is the necessary antecedent to nitrification in the case of organic matter and that adequate moisture will assist the process, but, while high concentrations of ammonia inhibit nitrification, yet such ammonia is absorbed by the soil and will subsequently be nitrified.

The most important point elucidated in connection with the work of green manuring was the liability to failure of this method owing to insufficient moisture in the soil. Experiments were therefore made by a preliminary soaking of the cut green manure crop in pits with water and then applying the fermented material which resembles indigo *seet* in composition. Trials of this method on wheat gave a very large increase of grain and further trials are being made with tobacco.

A number of soils from various parts of India were examined for *Azotobacter* and well marked differences were observed in the morphological and cultural characters of species of *Azotobacter* isolated from Pusa, Cawnpur, Darjeeling and Bangalore, and the amounts of nitrogen fixed by these also varied. It is also interesting to note that the addition of a seer of cane

sugar to a plot 2 square yards in area resulted in an increase in the nitrogen content of the first six inches of soil, of nearly fifteen per cent. during a period of ten weeks, and in view of the fact that many soil organisms produce soluble carbohydrates by their action upon the cellulose of buried organic residues, this stimulation of nitrogen activity may be found to be of considerable practical importance in the future.

Some interesting results were obtained from work on bacteriotoxins in soil and it has now been found possible to estimate the relative toxicity of various species by the use of plate cultures and the measurement of the rate of CO_2 formation. The importance of this line of enquiry lies in the fact that it is evident from experiment that such toxins inhibit nitrification, ammonification, and plant growth, a small quantity being required for the first of these and progressively greater ones for the second and third; it is also demonstrable that ordinary agricultural operations, such as tillage, destroy these toxins by aeration and exposure to desiccation and light, and owe part of their fertilizing effect to this action, the evident increase in nitrification resulting from tillage being in many cases largely due thereto, as well as to the provision of suitable moisture and air conditions for the action of nitrifiers. The study of the conditions under which toxins are formed and can be destroyed in soils is forming a large part of the work of this section.

Studies were also made of the physiological functions of the organisms involved in potato rot with a view to devising some method of dealing with the deterioration of tubers in store consequent on their action; the results of this investigation are being written up for publication as a Memoir. The biological factors in connection with the fermentation of rice beer were the subject of enquiry with a view to determine the feasibility of the regulation of the manufacture of the ferment, which is at present in the hands of an unsuitable class, who make the ferment according to old methods resulting in a variation in the quality of the fermented liquor due to the presence of numerous varieties of micro-organisms in the *Bakhar*, while in the rice beer itself there may be deleterious substances

derived from the same source. Control of the yeast manufacture would provide brewers with a reliable ferment of uniform composition and action, as it has been found from an examination of samples of this material obtained from various sources that the fermenting organisms present differ widely in character and effect. Of the different species of fungi found in samples of *Bakhar* none compared favourably in diastasic powers with *Aspergillus Oryzæ* which is the organism used for this purpose in Japan in the manufacture of *Sake* or rice beer and it is possible that the introduction of *Aspergillus Oryzæ* into India might considerably improve the fermentation of rice beer in this country.

PART II.

Progress in the Provinces.

1. *Bombay.*—Mr. G. F. Keatinge, I.C.S., returned from leave during the latter half of the period under report after an extended tour in America, Hawaii, Japan, Formosa and Java made with a view to studying the methods of sugarcane cultivation in those countries. He has submitted a very interesting report on his observations in connection with this industry as well as other subjects of an agricultural nature. The expert staff of the Department has been strengthened by the addition of a post of third Deputy Director and of second Economic Botanist. Thus there are now three Deputy Directors, one Agricultural Engineer, one Extra Deputy Director, four Divisional Inspectors and 88 agricultural graduates and non-graduate fieldmen, besides the staff of the Agricultural College and Research Institute. There are 20 agricultural stations and 10 plots and sub-stations scattered all over the Presidency, and there is a graduate fieldman for almost every District for demonstration work under the supervision of the four Divisional Inspectors. Last year the Department held 10 agricultural shows of some size and 111 formal demonstrations apart from the informal propaganda which occupies a large part of the time of the district staff.

The work of the Bombay Department would seem to have arrived at a somewhat definite stage of development, and close relations appear to have been established with the cultivators in the regions where the Department has had most opportunities for working. The genuine demand on the part of the cultivating classes for agricultural vernacular schools in the different tracts, the establishment of co-operative societies organized directly for agricultural improvements, such as dairy societies, cattle breeding societies, and seed societies, and the wide circulation of the vernacular journals issued by various agricultural associations and supported by the Department, indicate the awakening of interest among the agricultural popu-

lation, and also show the extensive and varied nature of the activities of the Department.

Among crops, cotton has occupied a large part of the Department's time, but other crops have also received considerable attention. Good varieties of wheat, rice and sugarcane have been introduced into tracts where they are likely to spread while the cultivation of groundnut is gradually spreading in the Deccan, Southern Maratha country and Konkan.

There is a large demand for the iron ploughs introduced by the Department. From the College Farm alone implements worth about Rs. 20,000 are supplied annually, while an iron plough manufactory started in the Satara District often disposes of as many as 500 in a month. Their introduction will no doubt have a beneficial effect on the general cultivation and thereby enable improved seed to show its value.

Among other important matters of a general nature under consideration have been the allotment and effective use of canal water and the provision of fodder for cattle in times of famine.

Perhaps the most interesting development of the Department's activity has been in the engineering branch. Much of real benefit to agriculture has already been achieved, chiefly in the way of water lifting, cane crushing by machinery and well boring, and there is great promise of future success.

Speaking of well boring in Gujarat the Director writes :—

"We have, by our restricted operations, extended over five years, added to the irrigation resources of Gujarat an increase amounting to 900,000 gallons per hour; and most important of all, we have demonstrated the possibility of finding subsoil water under pressure with fair certainty in large tracts * * * * * * . There can be little doubt of the possibility of turning Upper Gujarat into one large garden, and we have to see that this possibility is gradually realized."

2. *Madras.*—Mr. D. T. Chadwick, I.C.S., was in charge of the office of the Director of Agriculture throughout the year. The expert staff was strengthened by the appointment of Mr. Roger Thomas as third Deputy Director, who was, as a temporary measure, put under the Principal at Coimbatore and

subsequently under the Deputy Director in the Southern Division for training. The subordinate staff was also strengthened, but owing to the want of suitably trained men the actual strength of the staff was 43 against a sanctioned strength of 51. Proposals for increasing the number of divisions and for strengthening and reorganising the subordinate district staff are under consideration.

The Department is making marked development, especially in connection with the cultivation and manuring of the rice crop. In Chingleput alone about 32,000 lbs. of green manuring seeds were disposed of and the Director states that it is impossible to estimate the ultimate demand which will arise for these seeds when trained men are sent out to popularize the practice in the rice districts.

Considerable progress has been made in the operations for the eradication of palm disease by operating upon the infected living trees instead of confining the work to the removal of dead trees as was hitherto done, and there are indications of the abatement of the disease in the Kistna district.

Mr. E. Ballard, who came from Nyassaland, assumed charge as Government Entomologist from Mr. T. Bainbrigge Fletcher on 6th January 1914, and is engaged on the study of local insect-pests affecting important crops of the Presidency. Mr. Fletcher while in Madras wrote an important book entitled "Some South Indian Insects and other Animals of Economic Importance."

Mr. Sampson's interesting report on a cattle survey of the Madras Presidency has resulted in a proposal to make systematic efforts to improve the draught and milking qualities of cattle of Southern India.

3. *Central Provinces.*—The post of the Director of Agriculture was held by six officers during the year under report. These constant changes together with the absence of various members of the expert staff on leave for prolonged periods may be said to have prejudiced the working of the Department to some extent.

Two more posts have been added to the superior expert staff, one of which has been filled by Mr. Ritchie as Assistant Direc-

tor of Agriculture, Southern Division. The other post of third Deputy Director was vacant.

The Department continues its successful progress in the demonstrating of improved practices and seed distribution and in the economical running of some of its farms. In addition, progress has also been made in cattle breeding and dairy farming. A co-operative dairy has been started at Nagpur in order to ensure a pure supply of milk to the town and to improve the quality of the milch stock of the people (*Gaolies*) who are engaged in the milk trade. A full account of this dairy is published in the July 1914 number of the *Agricultural Journal of India*. Owing to the dishonest dealings of these people it is found difficult to get them to co-operate with any degree of success, but the Department is endeavouring to demonstrate the best methods by which they can improve their cattle and their methods.

There is also a Government dairy attached to the Nagpur Farm, the economical running of which will prove an object lesson in what can be done to improve the milk supply in large towns.

In Chhattisgarh where the inefficiency of plough cattle has long been an obstacle to the introduction of improved methods of cultivation, the Department's efforts to improve the breed have created much interest in parts of the Division, with the result that private co-operative cattle breeding farms have been started in some places and it is expected that they will extend largely when suitable bulls become available.

The work of the Botanical Section is hampered to some extent owing to the difficulties of accommodation pending the completion of the new laboratories. Mr. Graham has, however, done some practical work in disseminating seed of new varieties of chillies which is a paying crop in the Central Provinces and in investigating the possibilities of various tracts for vegetable and fruit-growing. An experimental orange garden has been started in Nagpur to serve as an object lesson to the neighbouring fruit growers, and proposals have been made for demon-

strating the possibilities of fruit and vegetable growing at Chhindwara.

4. *Bengal.*—Mr. J. R. Blackwood, I.C.S., remained in charge of the Department throughout the year. Mr. A. A. Meggitt, Agricultural Chemist, was transferred to Assam and Mr. H. E. Annett was appointed in his place. Mr. R. S. Finlow, Fibre Expert, was absent on leave throughout the year. The post of second Deputy Director of Agriculture, sanctioned by the Secretary of State, remained vacant. The number of demonstrators was increased during the year under review from 47 to 54.

A beginning has been made in utilizing co-operative credit societies for spreading the use of improved seed, manures and implements. With the main object of developing good types of milch cow and draught bullock suited to the climatic conditions of the Province, a dairy farm has been started at Rangpur, but it has not yet been possible to obtain the full number of cows required.

Mr. Annett, the Agricultural Chemist, is engaged in a scientific investigation to elucidate the mechanism of the production of sugar in the palm tree and also in the study of the enzymes present in various Indian seeds. He has found that the swordbean contains a ferment which can rapidly change urea into ammonium salts. This discovery might be useful for the purpose of determining the proportion of urea in urine or blood. He has also taken up the soil survey of the Province.

Mr. Hector continued his work on rice to which reference is made in Part IV of this report.

With a view to improve the outturn of jute per acre, each demonstrator in a jute area conducted demonstrations in plant to plant selection. It is to be hoped that the pure line cultures of jute worked out by Mr. Finlow will prove superior to any other race cultivated in Bengal and steps will be taken next year to test Mr. Finlow's seed against the seed of the best local varieties.

Mr. Southwell, Deputy Director of Fisheries, Bengal and Bihar and Orissa, worked out an important scheme for initiat-

ing trawling on commercial lines in the Bay of Bengal. He is also preparing a similar scheme for opening out the Sundarbans fisheries.

5. *Bihar and Orissa.*—Mr. G. Milne, I.C.S., continued to act as Director of the Department of Agriculture except from 26th November 1913 to 17th March 1914, when Mr. Heycock, the substantive incumbent of the post, held charge of the Department.

A combined cattle breeding and sugarcane experiment farm was opened at Sipaya with Mr. M. M. Mackenzie as Superintendent, but later on it was decided to use it solely as a cattle breeding station and to start a separate sugarcane station in the north of Bihar.

Mr. Woodhouse continued to hold charge of the Principalship of the Sabour College in addition to his own duties as Economic Botanist. Investigations on the sugarcane varieties were continued and a paper on the subject was prepared for publication in collaboration with Mr. S. K. Basu.

Campaigns against "Greasy surface caterpillars" were undertaken at Mokameh Tal, Ekchari (near Colgong) and Tanrar (near Ghogha), with the result that in the last two places where the attack normally extends over an area of 8,000 bighas, the damage was reduced to a nominal area of 20 bighas. At Mokameh Tal, however, owing to abnormal flood conditions and other factors, the attack was unusually serious and extended over an area of about 5,000 bighas.

Mr. Somers Taylor's work on sugarcane, which is likely to be of considerable value in future variety trials, has been referred to under sugarcane in Part IV of this report.

The work of the Department again suffered from the necessity of maintaining an extensive organization of experimental and demonstration farms scattered over a much larger area than a single Deputy Director can be expected to manage successfully. Sanction has, however, been obtained for employment of two more Deputy Directors and an Assistant Director, and it is hoped that it will now be possible to bring the farms under proper control and to make steady progress in demonstration and other useful work.

6. *Assam.*—Mr. J. McSwiney, I.C.S., held charge of the Department till 2nd April 1914, when Mr. A. R. Edwards, I.C.S., succeeded him. Mr. A. A. Meggitt joined the Department in January, 1914, as Agricultural Chemist, and proceeded on leave from the 5th April, 1914. Rai Bahadur B. C. Basu was on special duty in the Department throughout the year, first to enquire into the silk industry of Assam and then to help Mr. Birt, Deputy Director of Agriculture, in his work. There is no post of Botanist for this province, but the advice of Mr. G. P. Hector, Economic Botanist, Bengal, is sought for when required.

In addition to the existing experiment stations two more stations were opened during the year—one at Karimgunj in Sylhet for experiments with rice, and the other at Khagrabari in Kamrup for sugarcane experiments on a large scale with steam tackle, under the management of Mr. C. S. Chaston.

Mr. Meggitt was engaged in soil investigation work and some elaborate field experiments with the object of ascertaining the functions of lime in the soil. Full advantage cannot, however, be taken of his services till his laboratory is ready for use. Some striking results have been obtained at Jorhat by the use of ground limestone in conjunction with green manure.

The extension of the Department's activities has brought with it such an increase in the work of inspection and administration that a second Deputy Director is urgently required and the question of his appointment is under consideration. The need of more district staff for extending operations in districts where there is scope for improvement is keenly felt .

Although the attention of the Department has been mainly centred on the improvement of the staple crops of the Province such as paddy, potatoes, and sugarcane, nevertheless the question of extending the area of jute cultivation has not been overlooked. A large area of land in Kamrup has been given on favourable terms to a leading Calcutta firm to enable an experiment in jute cultivation to be carried out on an extensive scale.

At present the improvements effected by the Department reach the cultivators through the medium of Associates and Correspondents who numbered 28 during the year under report,

but attempts are being made to establish closer relations by means of co-operative societies.

7. *United Provinces.*—The Hon'ble Mr. Hailey, I.C.S., remained in charge of the Department throughout the year. The only addition to the superior staff was the appointment of Mr. F. H. Vick as Agricultural Engineer. A post of third Deputy Director of Agriculture was sanctioned, but could not be filled until the close of the year.

The main features of the year are clearly set out in the Director's report from which the following extracts are taken :—

"Research and experimental work have been continuously carried on at the various Agricultural Stations; but the more immediate necessity is the development of organizations through which the results gained by this work in the past may be introduced into the agriculture of the provinces, and through which the officers of the Department may keep in touch with the agricultural community and exercise the influence which is essential to progress. To a large extent this consists in developing relations with local bodies, such as district boards, co-operative societies and influential landlords, who are willing to further the work of the Department in such matters as demonstration, the multiplication and distribution of improved varieties of seed, sale of implements, provision of water supply, etc. * * * * * * . Before, however, what I have termed the local agencies, can render effective assistance they must be provided with the necessary machinery: they must arrange for the acquisition or control of land for demonstration and seed production, godowns for storing seed and implements, and some sort of staff for conducting operations. For carrying out these arrangements they need the advice and guidance of the Department. It is this side of the work of the Department which has come into increasing prominence during the year, and in which most development has taken place.

"New district farms have been opened during the year in the Bulandshahr and Saharanpur districts; while * * * * a number of small farms have been opened in the Eastern Circle in co-operation with landlords, or the local boards. Some of these such as the Bulandshahr and Ballia farms are partly supported by the District Boards. At Mainpuri, the Agricultural Association have started a farm which is being managed by the Department. Seed is supplied from these farms to the co-operative societies or landlords, working in con-

junction with the Department, who undertake to multiply it and distribute among the members of the society or their tenants. In the Eastern Circle a number of private farms have been opened for this purpose. So far as possible land for the district farms is being taken up near headquarters, so that they may be readily accessible to the public and visited by co-operators at their meetings. In certain instances it has been arranged that these meetings shall be held at the farms.

"Some of the District Boards are now beginning to take an interest in agricultural improvement and to show it in a practical form. * * * Applications continue to be received from landlords to provide trained men to run demonstration farms they are anxious to open. For the most part it is quite impossible to comply with such requests; but, with the activity now shown by District Boards they form good indications of the growing interest taken in agricultural improvement.

"Another noticeable marked development of the year has been the extended use of mechanical power for water lifting following on the appointment of the agricultural engineer. It has been most marked in the western districts, particularly in the Bulandshahr district, where the greatest assistance has been received from Chaudhuri Amar Singh, who has started a school to instruct drivers. * * * ."

The main crops on which the activities of the Department are concentrated are sugarcane, cotton and wheat, to all of which reference has been made in the sections devoted to these crops in Part IV of this report.

8. *Punjab.*—Mr. W. S. Hamilton, I.C.S., held charge of the Department throughout the year. The superior staff of the Punjab Department has been increased during the year by the appointment of Sardar Darshan Singh as second Deputy Director and Mr. Miller Brownlie as Agricultural Engineer. A post of third Deputy Director has also been sanctioned, but it was not filled up until after the close of the year. These additions will now enable the Department to extend its energies which were so far confined to a few districts. A need for more men for research work is, however, still felt, and the Director has represented the matter to the Local Government, asking for the appointment of an Assistant Agricultural Chemist and of an Entomologist. He has also submitted a scheme for improving the pay of Assistants in order to attract better men to the College.

The year was not a good one from an agricultural point of view and the experiments on all the farms suffered more or less through the unusual weather and the attacks of pests. One of the best varieties of American cotton, of which 400 acres were sown in the Lyallpur district, suffered severely from the attacks of jassids. This variety has now been discarded and another type of a more hardy nature has been taken up.

The district work in the Punjab which consists mostly in demonstrating the use of implements, green manuring with *sann*, and sowing of tested varieties of wheat and cotton is done through the medium of the Agricultural Associations. These have been formed in some districts and are said to be doing useful work; but in order to make them more useful both money and staff are wanted. A need is also felt for seed farms owned by co-operative societies constituted for the special purpose of distribution and multiplication of seed and the matter is under consideration of both the Director and the Registrar, Co-operative Credit Societies. It is to be hoped that some societies will soon be formed. The credit societies are not considered likely to be of use in this matter as the members are not necessarily much interested in agricultural improvement, and the leading agriculturists do not take readily to the co-operative credit movement.

Mr. Cousins, lately a military department officer, who has had long practical experience in bee-keeping, is assisting and advising bee-keepers in the Province as well as designing suitable appliances and investigating methods of improvement.

9. *North-West Frontier Province.*—The work in this province is chiefly confined to the Peshawar Agricultural Station where results of substantial value have been achieved, especially in the introduction of European crops, and in the improvement of fruit culture.

With regard to improvement in general cultivation Mr. Robertson Brown, the Agricultural Officer, writes in his annual report as follows:—

"Zamindars of the North-West Frontier Province, and especially of the Peshawar District, have considerable skill in the cultivation of their

crops, and failures are rarely due to lack of agricultural knowledge. Extensive trials in methods of cultivation during the past four years show that the practices in vogue generally suit the local conditions.

"Until circumstances are propitious for the introduction of agricultural co-operation the attention of the Department is being chiefly devoted to the production of pure stocks of wheat, maize, cotton and fruit trees, and every effort is made to arouse the interest and zeal of landowners by maintaining the Agricultural Station in a high state of cultivation."

Excellent varieties of marketable peaches, plums, and oranges have been found to bear abundantly at the Tarnab Agricultural Station, a tree of a selected variety of peach having been found to give a larger number of good fruits than is possible from an average acre of ordinary local seedling peaches. Thus there are considerable possibilities of effecting improvements in fruit culture in the Peshawar Valley.

Another marked success of the year was the investigation of the fact that sugar beets of good manufacturing quality can be grown in the valley so as to give a crop from 15th March to 15th June.

Remarkable success continues to be obtained in the growing of winter fodders, especially rye-grass which yields four heavy green cuttings and a good crop of hay in May or June. It gives an excellent green fodder for horses and may prove of immense use on irrigated grass farms.

10. *Burma.*—Mr. H. Clayton, M.A., I.C.S., remained in charge of the Department throughout the year, and there were no changes in the superior staff of the Department.

Several new farms have been opened and the subordinate staff has been increased. The work of the Burma Department is still in an experimental stage and cannot, therefore, be expected to produce results of much economic importance. Much insight has, however, been obtained into local conditions and local crops. Some promising pure line cultures of paddy and other crops have been isolated and grown on the stations of the Department. Mr. Warth, the Agricultural Chemist, has continued the study of the composition and seed weight of rice grains which have been observed to show marked differences in

the same variety of paddy on different soils. Cotton is also receiving increased attention as mentioned later on in the section devoted to this crop.

But the most striking feature of the past few years is the extent to which the Department has succeeded in enlisting the sympathies and interest of the people by maintaining close relations with the Co-operative Department.

11. *Mysore.*—Dr. L. C. Coleman, M.A., remained in charge of the Department as Director. The appointments of a Deputy Director and an Assistant Director were sanctioned and the strength of the Department was adequately increased with the result that both experimental and demonstration work was further extended. The experimental work on sugarcane has given fairly definite results indicating that the most favourable season for planting extends from December to March. Demonstrations of a threshing machine run by an oil engine and of improved methods of making jaggery are items of work worthy of special note.

The work in connection with *Koleroga* has expanded very rapidly and with quite satisfactory results. The spike disease of sandal and two serious coffee diseases which are responsible for annual losses probably aggregating to several lakhs of rupees have also been taken up energetically.

On the entomological side the most important item of work has been in connection with the Green Scale Insect, *Lecanium viride,* on coffee which has been recently introduced into the State. Efficient measures for the control of *Kumbhihula,* (*Amsacta albistriga*) at a very small expense to cultivators have been worked out and widely demonstrated.

12. *Travancore.*—In this State there are at present three experimental farms, under the supervision of the Director of Agriculture (Dr. N. Kunjan Pillai, M.A., B.Sc.), devoted to sugarcane, groundnut, cotton, root crops and coconut, and a fourth is to be opened specially for rice. In addition, there are cattle breeding and silk farms and a demonstration farm mainly for the cultivation of guinea-grass.

The chief progress made in the State is in the popularization of manures for coconut and rice, the two most important

crops in Travancore. A number of manure depôts are run by the Department in different parts of the State, the manures chiefly consisting of stuffs available locally, such as oil cakes, fish manure, etc., which would otherwise be exported.

Some success has also been achieved in popularizing the transplantation of single seedling rice and in the introduction of light iron ploughs, while the efforts to improve the local breed by distribution of stud-bulls are said to have added Rs. 50,000 to the income of the *rayats* during the last six years.

But perhaps the most important work is that of combating the coconut palm disease which is rapidly becoming of serious importance in the State. By the destruction of irrecoverable trees and by paying increased attention to cultivation and manuring, it is said that the general condition of the trees within infected areas is being gradually improved.

13. *Baroda.*—Mr. M. A. Sitole, B.A., M.R.A.C., remained in charge of the Department as Director. The State has a model and a demonstration farm, besides a farm in an aboriginal tract which gives Bhil boys and girls practical instruction in methods of raising crops. There are at present two Agricultural Associations and two Agricultural Co-operative Unions besides many honorary correspondents through whose agency the improvements effected by the Department are brought home to the cultivators. On the demonstration farm batches of cultivators are invited from time to time and lectures regarding the different methods of general improvement in agriculture are given.

Iron ploughs are greatly used and there is a demand for oil engines and pumps for extensive irrigation. The Durbar have sanctioned a grant of Rs. 42,000 for advancing *tacavi* by way of help for the purchase of engines and pumps through the Department and Rs. 11,000 were advanced for the purpose to four enthusiastic agriculturists during the year.

Reclamation of ravines by dams and terracing is giving promise of converting thousands of acres of such land in the State into agricultural land.

Groundnut is being successfully introduced in many parts and attempts are made to introduce lac and sericulture.

14. *Kashmir.*—Mr. Ram Gopal, M.A., M.R.A.C., held charge of the Department of Agriculture of the State during the year.

Experiments with various crops to discover varieties best suited to Kashmir were continued and manurial experiments with tobacco, paddy and groundnut were started. Some fibre experiments are also in progress.

The work of seed distribution and introduction of improved implements has so far been on a very small scale. The help of Co-operative Societies is needed in these items of work, but such societies have yet to be started.

PART III.

Progress in veterinary work.

The table opposite shows at a glance the organization of Provincial Veterinary Departments and the degree of success attained by them in the control of diseases. The increase in the numbers of cases treated in hospitals and dispensaries, and by officers on tour, as well as the number of inoculations made, indicate that steady progress has been made in winning the confidence of the people which is an indispensable condition for the success of the Department's work. Indeed, no better proof of such confidence could be forthcoming than the facts that at least in one of the provinces—the Punjab, many private individuals came forward to establish Veterinary Hospitals at their own expense and that in the Central Provinces, some of the cattle owners voluntarily deposited the cost of 500 doses of anti-rinderpest serum, which was subsequently returned to them. The fall in the number (0·23 per cent.) of deaths after inoculation is slight but encouraging.

Striking instances of the efficacy of anti-rinderpest serum were demonstrated at Gaisabad and Chanda in the Central Provinces, where 7,233 cattle were inoculated, with no mortality among the inoculated animals. While in some of the provinces the Department has to combat the prejudice which still exists among the people against inoculation, it is gratifying to observe that in other provinces cattle owners now look upon inoculation against rinderpest with great favour and regard it as the only satisfactory measure to be adopted.

In some of the provinces Rinderpest was more widespread than in previous years and a far greater advance in the number of animals inoculated might have been recorded but for the most unfortunate breakdown in the supply of serum from Muktesar during the greater part of the year. The breakdown of the centrifuges at the Imperial Bacteriological Laboratory at Muktesar in June 1913 seriously handicapped the work of preparing serum which had to be carried on by the clotting

Province.	No. of superior staff.	*Veterinary Colleges and Schools.*			*Dispensaries and hospitals.*		*District staff and work.*						
		Research.	No. of students at end of year.	No. of subordinate Teachers.	No. of dispensaries.	No. of cases treated in hospitals and dispensaries in the year.	No. of Inspectors.	No. of Veterinary Assistants.	Outbreaks reported.	Cases treated and castrations performed on tour.	Deaths uninoculated.	Inoculations.	Deaths after inoculation.
Punjab	10+3*	Examination of specimens and diagnosis.	120	..	115	3,03,055	15	176	324	1,02,447	3,808	52,314	53
Assam	1	*Nil*	..	..	2	4,462	3	37	236	65,594	4,954	26,325	382
Burma	3+6†	Diagnosis	48	1	1	1,428	13	137	47	80,076	410	5,223	41
Bombay	4+6‡	Diagnosis	88	..	50	1,20,741	3	59	72	38,870	829	12,405	47
Sind	1+1†	*Nil*	..	..	11	16,013	..	11	4	2,918	84	856	2
Ajmer-Merwara	..	*Nil*	..	..	2	1,380	..	3	1	252	6	103	1
Baluchistan	..	*Nil*	..	..	4	3,233	1	5	5	2,064	170	1,074	1
United Provinces	2+1†	Tuberculosis; spirochetosis; Kumri.	..	..	49	56,467	17	156	573	90,067	5,298	66,022	19
Bengal	3+7†	Blistering Beetles; Septicæmia; worm nodules.	56	6	18	21,503	16	75	308	50,598	3,754	31,304	197
Bihar and Orissa	1	*Nil*	..	..	23	23,849	7	55	393	40,442	3,691	1,21,020	158
North-West Frontier Province	..	*Nil*	..	..	19	56,459	2	27	30	23,028	170	12,606	2
Madras	2+2§	Protozoal infections	52	3	21	24,456	7	71	285	16,788	2,756	37,657	15
Central Provinces	2+2†	Protozoal infections; Piroplasmosis.	..	..	78	1,04,953	11	102	1,073	91,849	15,316	95,100	158
TOTAL FOR 1913-14	57		364	10	393	7,37,999	95	914	3,351	6,04,993	41,246	4,62,009	1,076
TOTAL FOR 1912-13	29		319	10	374	6,56,296	89	849	3,950	4,73,942	48,918	4,67,860	1,659

* Two Indian Professors and one Deputy Superintendent.
† Deputy Superintendents.
‡ 2 Deputy Superintendents, 4 Indian Professors and Assistant Professors.
§ One Deputy Superintendent, one Assistant Principal.

method and by the aid of old centrifuges; and, while the outturn was consequently enormously reduced, the demand was so large that in spite of every endeavour it could not be complied with in full. Large orders for the serum from Egypt and the Soudan and the enquiry for it from Rhodesia had to be set aside. Since the close of the year under report, it has, however, been found possible to work some of the new centrifuges at half speed. It is hoped that the increasing demand for rinderpest serum, both in India and outside, will be fully met when new centrifuges are installed and the removal and expansion of the Branch Bacteriological Laboratory at Bareilly to its new site is completed.

The experiment initiated last year to combat Hæmorrhagic Septicæmia in the Chota Nagpur Division (Bihar and Orissa) through the agency of locally trained inoculators, was carried out during the year with the co-operation of the missionaries. 28 Christian boys attended a class in Ranchi and were taught the necessary details for carrying out the work. After training, they were posted to their respective stations and under the supervision of the Missionary in charge toured in the adjacent villages. Two Reserve Veterinary Inspectors were put in charge of them as Inspectors of Inoculators and during the course of 9 months September to March 1914, they inoculated 67,911 cattle. The policy to be adopted for the future conduct of the scheme is under the consideration of the Local Government.

The initiation of a post-graduate course in Veterinary Bacteriology and Veterinary Science in the Bombay Veterinary College and the extension of the Punjab Veterinary College course to four years to be followed by a post-graduate course for one year, are noteworthy features of the year.

In the Madras Presidency, attempts were made to introduce a system of meat inspection at municipal slaughter-houses by qualified Veterinary Assistants in towns where the Municipalities agree and in which such men are available; while in the United Provinces, a series of lectures and demonstrations in meat inspection was delivered to the recently appointed health officers of the Medical Department. In Bengal, two courses

of 10 lectures each on infectious diseases of animals were delivered to the students under training for employment as Sanitary Inspectors in Municipalities.

Special endeavours were made to improve the sheep industry of the Punjab. Sheep-breeding experiments, undertaken in the United Provinces with a view to ascertain to what extent it is possible to improve the fleece of the indigenous sheep, have so far given very satisfactory results: the introduction of a merino cross has been found to have a very beneficial effect on both the quantity and quality of the fleece. Similar experiments were also in progress under the Imperial Agriculturist at Pusa.

As regards research, while a certain amount was done by individual officers of the Provincial Departments, the greater part was concentrated at the Imperial Bacteriological Laboratory at Muktesar where a great deal of useful work on Rinderpest, Surra, Anthrax, Kumri and Bursati was carried out. The Camel Specialist also made a large number of useful observations and some progress in the discovery of a safe cure for surra. The Imperial Pathological Entomologist at Pusa, in addition to the surra investigation at Kathgodam and Muktesar, continued work on the bionomics of flies likely to be surra carriers, on the habits and life-history of lice and on the egg-laying reactions of blood-sucking Muscidæ.

The post of Physiological Chemist, vacated by Dr. Hartley in February 1913, and the new post of Pathologist on the staff of the Imperial Bacteriological Laboratory at Muktesar, sanctioned by the Secretary of State in July 1913, remained vacant during the year under report, but since the close of the year Dr. G. H. K. Macalister has joined the post of Pathologist and Mr. R. V. Norris who has been appointed as Physiological Chemist is expected to arrive shortly.

PART IV.

Crops and Special Subjects.

1.—*Crops.*

(*a*) **Rice.**—The work on this most important crop continues on three lines as before—

(*a*) Selection.
(*b*) Transplanting.
(*c*) Manuring.

With regard to (*a*) the propagation of single selected strains is going on at nearly every experimental farm in Madras and a strain (which was referred to in last year's report at Palur) of *garundansamba* called *ramagarudansamba* has this year given an acre yield of 2,528 lbs. against 2,000 lbs. per acre of the ordinary single crop *samba* variety.—The appointment of Mr. F. R. Parnell as Economic Botanist to Madras should materially assist the progress of this branch of work in the near future.

Useful work on these lines is also in progress in Bombay, Central Provinces, Bengal and Burma. There are numerous varieties of rice at present existing in different provinces and the object of the botanical study is to produce an improved strain of the more important varieties to be found in the chief rice-growing tracts by working out an agricultural classification based on characters other than the purely morphological. In Bengal, Mr. Hector, the Economic Botanist, has isolated half a dozen of the best types of *aman* paddy which, when grown on a field scale, gave an outturn varying from 1,400 lbs. to 2,100 lbs. in spite of an unfavourable season. This work promises to be of great practical value and it is proposed to try the type which has given best results in point of outturn on a much larger scale. Similar results have been obtained in Burma with a pure variety of *Kalagyi*. Mr. Hector has also obtained a large number of natural hybrids in pure line culture, some of which may possibly prove of economic value.

In Burma intra-varietal selection and also cross-pollination tests have been devised with special reference to grain colour as the red colouration of the husked grain is considered to be the most serious defect of Burma rice. Mr. Hector's experiments with a simple method of selecting seed by specific gravity for sowing purposes will probably be of great use to the Bengal *rayats*.

(*b*) *Transplanting.*—Madras continues to make steady progress in the popularization of the method of single seedling transplantation which is so obviously reducing the seed rate and improving the yield that its general adoption will only be a matter of time. In Godavari, Tanjore and other southern districts, the usual seed rate was about 100 to 150 lbs. per acre and bunches of from 5 to 8 and even 16 plants were transplanted. By single seedling transplantation the rate was reduced to 20 lbs. resulting in a saving of about Rs. 3 an acre in seed alone without affecting the outturn. The system has been very widely taken up in Tanjore and other southern districts and it is estimated that the profit arising therefrom must be worth about 10 lakhs of rupees a year. Taking into consideration the area of 10 million acres of paddy in the Presidency, of which more than $\frac{1}{3}$ is transplanted, it will appear that there is still much to be done in this direction. In Mysore and Travancore the popularization of single seedling transplantation and growing of Banku paddy introduced from the Central Provinces is meeting with equal success.

As usual the popular methods for disseminating information adopted in the Central Provinces have resulted in a grand total of 30,000 acres being put under transplantation in the year under report, and it looks as if in the future this work may have to wait on the exigencies of the Irrigation Department as soon like Alexander it will have no more "irrigated" lands to conquer.

The material advantage is shown by the fact that taking the value of the increased yield of a transplanted crop at the low figure of Rs. 15 per acre, this transplantation has resulted in an increased profit of some $4\frac{1}{2}$ lakhs to the cultivators concerned.

UFRA OF RICE.

EXPLANATION OF PLATE.

Fig. 1.—Ufra of rice. Advanced stage of *pucca* ufra, showing the thinning of the stem above the top node and the discoloration at the base of the ear. Most of the grains are light. Specimen from Narayanganj. $\frac{1}{4}$ natural size.

,, 2.—Ditto from a Pusa inoculation. The stem lesion is less marked than in fig. 1 and the base of the ear is not affected. $\frac{1}{4}$ natural size.

,, 3.—Ditto from a Pusa inoculation, with sheath still in place, showing the characteristic symptoms of *pucca* ufra. $\frac{1}{4}$ natural size.

,, 4.—Ditto. A typical case of *thor* ufra of aus paddy from Begumganj. Natural size.

A party of 35 cultivators was taken over rice growing villages in Bhandara and Balaghat during the rains, a form of agricultural demonstration which is one of the finest methods of getting at the most ignorant and backward.

(*c*) *Manuring.*—The experience so far gained appears to be in favour of green-manuring where paddy is transplanted and successful efforts are being made to spread the practice in various provinces. Castor cake or green leaf together with super-phosphate continues to show its superiority as a manure for paddy in Madras, the increased yields averaging about 700 lbs. of grain per acre. In Travancore and Mysore oil cakes and bone meal seem to produce the largest yield and their use is being widely demonstrated. In Travancore calcium cyanamide is also recommended as the best nitrogenous fertilizer, while in Assam the use of bone meal is being demonstrated with favourable results but in the case of such a manure it is essential to wait until after the third season. It is interesting in view of the above differences to note that at the Board of Agriculture in 1913 the committee appointed with a view to examining the work already done and to working out a scheme for further investigations on the subject of paddy, suggested among other things, that as the crop is cultivated under vastly different conditions in the various provinces, each province must work out for itself the problems connected with cultivation and the methods of cultivation.

On the chemical side, Mr. Harrison in Madras continued his investigations into the conditions affecting the cultivation of paddy under swamp conditions. The results which throw considerable light on some of the factors essential for the maximum growth and yield of paddy have been published in the Chemical Memoir, Vol. IV, No. 1. Enquiries on useful and practical lines have also been started in Burma and Bengal dealing with manuring, early ripening and other important factors affecting the yield and quality of the grain.

The most serious disease of rice is that which is known as *Ufra* in Eastern Bengal. The losses caused by it are very heavy, nearly half the winter crop having been lost in 1911 in one place while in another *thana* about 200,000 maunds of grain

were lost in 1910. This disease has therefore engaged a greater part of the attention of the Mycological Section of the Pusa Institute. It has been found that the organism responsible for the damage is a form of eelworm which remains immotile and dormant in the dry grains after December and probably commences activity only with the flooding of the fields after sowing. The disease persists owing to the worms remaining dormant in the soil after the harvest. During the present year efforts have been made to map out the extent of the infected area and an experiment is in progress at Comilla to test remedial measures. It is probable that burning the stubble on the soil after winter harvest will be found to be the most efficient means of combating the disease.

(*b*) **Cotton.**—Attention continued to be devoted to the improvement of this crop on the lines described in last year's report, the chief objects being (*a*) the improvement in the quality of the lint, and (*b*) the increase in yield.

In Madras considerable improvement has been effected in raising the general level of the crop in Tinnevelly by the distribution, through a chain of seed farms, of better seed obtained by bulk selection and by the introduction of the seed-drill and bullock-hoe for sowing and interculture. Formerly the crop in this tract consisted of a mixture of two varieties and the seed used to be sown broadcast which admitted of no cultivation after sowing. The advantages of selected seed of one variety combined with improved cultivation were therefore so obvious that by 1910-11 there was a tract of nearly 100,000 acres in the district all under one variety which six years previously had been grown with a mixed crop, and the local firms commented favourably on the general improvement in the quality of the cotton in this tract. Subsequently, however, owing to the establishment of ginning factories which ousted the old hand gins, it became difficult for the cultivators to get back pure seed and the policy of seed distribution had therefore to be revised. The area of seed farms has now been restricted to an extent (about 500 acres) which can be sown with seed raised on the Government Farm at Koilpatti. The seed from these farms is sold in the villages and arrangements have been made

with the ginning firms to gin separately any consignment of this cotton which they may bring in. This method has now been adopted in 20 villages and there is a large demand for selected seed at prices 40 per cent. above rates for ordinary bazar seed.

Side by side with the bulk selection the Madras Department carried out single plant selections on the Government Farm with the result that it has succeeded in separating out three single strains which are of marked superiority in quality and ginning percentage over the ordinary selected variety. One of these selections has already been grown over 300 acres and this year there is sufficient seed for 7,000 acres. The increased profit from this strain over the bulk selection is estimated to be Rs. 12 to Rs. 16 per acre or Rs. 20 to Rs. 25 per acre above the *rayat's* ordinary crop.

Work on similar lines was also undertaken in Kurnool and Bellary with the result that the area under selected seed in the former rose from 250 acres in 1909 to 11,000 acres in 1912. In 1913 there was a set-back owing to the bad year of 1912 which damaged the crop on seed farms. Owing to high ginning percentage the growing of this selected seed gives a profit of Rs. 5 an acre over the local crop, and the seed itself fetches prices 20 per cent. above local rates.

Up to the present the efforts of the Madras Department in connection with cotton improvement have been confined to these three districts and it is estimated that the improvements so far effected have been worth at least rupees four lakhs a year on an average. The work is capable of much expansion as these tracts have not yet been fully dealt with and there are other tracts which have not been touched at all.

A noteworthy feature of the year in connection with cotton improvement has been the formation of two co-operative societies to promote the cultivation of cotton from seed selected by the Department.

Cambodia cotton is now thoroughly established in the south of the Madras Presidency and has been a very striking example of an exceedingly valuable introduction by the Department. Owing principally to its capability of being grown with great profit on lands unsuited to Indian cotton it has spread very

rapidly through the efforts of the Department for its introduction in the beginning. It has supplanted crops which on an average gave a profit of Rs. 30 an acre. In 1912 there were about 60,000 acres under it, and at the prices then ruling yielded a profit of Rs. 180 an acre. Thus in that year alone this introduction added ninety lakhs of rupees to the wealth of the agricultural community. Owing to such enormous profits, the cultivation of this cotton attracted the attention of growers as well as dealers with the result that it began to be grown on unsuitable lands and partly through carelessness and partly through the middlemen who adulterated it with local cotton and tried to pass the whole off as *Cambodia*, the lint became impure and for this reason complaints are now common about its deterioration, but there are still places where it is grown pure and here it commands a premium of Rs. 20 a *candy* of 500 lbs. over the best country cotton. The efforts of the Department which are now being directed towards the selection and breeding of this cotton on a large scale and advising cultivators to restrict its cultivation to suitable areas, coupled with the co-operation of the trade, will, it is hoped, mitigate this evil.

Cambodia cotton has also been successfully introduced in some parts of Mysore where it promises to become one of the most important crops.

In Bombay, the difficulties in the way of securing full market value for improved quality are limiting the Department's efforts in the extension of the improvements effected. The introduction, into the Western part of the Dharwar cotton tract, of Broach cotton which has a higher ginning percentage than the local *Kumpta* has so far met with great success, and in the last auction sale organized by the Department the produce of about 2,500 acres brought to the cultivators a profit of about Rs. 40,000 over what they would have got by growing *Kumpta* cotton. But there are difficulties especially in connection with marketing, in the way of securing its more rapid extension. The same difficulties have been responsible for the restriction in Lower Gujarat, of the Department's efforts in the introduction of selected strains which were most favourably reported on by the trade. The syndicate which was formed in 1911 to pur-

chase this cotton at 5 per cent. over the local market rates had to suspend its operations owing to disputes as to what constituted the market rate.

From the experience so far gained in attempting to improve the quality of cotton in the Bombay Presidency, it has been realized that " in the present condition of the cultivators and of the cotton market, an improved cotton must have the following characteristics in order that it may obtain rapid success :—

(1) The improvement must be in quantity rather than quality.

(2) The improvement in quantity must be considerable and obvious; and

(3) The cultivation must involve no additional labour or risk to the cultivator."

From these points of view the efforts of the Department in Khandesh with regard to spreading the cultivation of the *roseum* cotton which yields more heavily and has a higher ginning percentage than the local mixture appear to be certain of success. It is worth Rs. 6 more per acre than the local cotton, and the cultivators are very keen on it. In order to meet the demand for seed, there is a large departmental seed farm besides 19 seed growers who grow pure seed on an area of 732 acres. The number of these seed growers will be steadily increased according to the demand. Last year about 100,000 lbs. of this seed capable of growing about 7,000 acres were sold.

Cambodia cotton is spreading in the south of Dharwar District and it appears probable that it will find a permanent place in the crops of the locality.

In Sind the cultivation of Egyptian cotton which at one time was grown on a considerable area has had to be given up owing to the uncertainty of the water supply and the poor methods of cultivation in vogue. It is possible that when perennial irrigation is extended in Sind this cotton will be profitably grown. In the meantime, the cultivation of American cotton which has been found to grow with seasonal irrigation and cultivation similar to that given to local cotton, is being pushed. This season a crop of 1,000 bales is expected and there is a special agency for marketing it. Some of the

zamindars have taken up this cotton and it is possible that if the prices are favourable it will be grown extensively.

The main feature of the cotton work in the Central Provinces has been the distribution of *roseum* seed through private cotton seed farms organized on a co-operative basis in Berar. These seed farms are grouped in co-operative unions, of which four have been registered under the Act, while 18 are unregistered. Departmental supervision is concentrated on the central farms of the Unions, the channel through which the seed from the Government Farm at Akola reaches the private farms and ultimately the general public. There are 400 such private seed farms and about 1,760,000 lbs. of seed were raised in 1914. This seed produces a crop of high ginning percentage which is worth Rs. 6 more per acre than the local mixture. There is therefore a great demand for the seed and it is estimated that there would be about 200,000 acres of it grown in 1914. This will mean a profit of about Rs. 12,00,000 in one season. It is proposed to increase the quantity of the seed available for distribution by about 1 million pounds each year and thereby to extend the area under it by approximately 100,000 acres. Thus in course of time the mixture will be entirely replaced by the one type over the whole of the tract.

Nitrate of soda with cattle dung has been found to be a profitable manure for cotton at the Akola farm and four tons of this fertilizer were sold from the farm during the year.

In the United Provinces, Mr. Leake is engaged in the study of the factors controlling the ginning percentage of Indian cottons, and the preliminary results have been published in the *Journal of Genetics*, IV, 1914. In these provinces the ginning percentage varies on an average from 30 to 33, while selected varieties have been isolated which give as much as 41 per cent.

In the Western Circle the cultivation of white flowered cotton giving a higher ginning percentage and better yields than the present mixture is rapidly extending, and arrangements are being made with co-operative societies for the distribution of the seed and with landlords and others for ginning the *kapas* and selling the seed to cultivators in the neigh-

bourhood. This cotton has spread rapidly in unirrigated tracts outside the best cotton growing area owing to its hardiness and yield. The additional value of this cotton over ordinary *deshi* has been estimated to be 8 or 9 lakhs on the area sown in 1914.

In the Central Circle, Cawnpur-American cotton yielded well in 1913 on a considerable scale and seed for 5,000 acres has been issued by the Department for this year's crop, the Elgin Mills having entered into an agreement to take the bulk of the crop.

In the Punjab, the cultivation of American cotton received a set-back owing to the attack of Jassids in 1913 and the Government sanctioned the payment of compensation to those whose crop was very poor. The damage was mainly done to a type which had smooth leaves and which has now been discarded. Another type which is more hardy and immune from the attacks of pests has been taken up. About 400 maunds of seed of this type were issued or sold by the Department last spring, and have been sown mostly under seed farm conditions. A lease of 3,000 acres on the Lower Bari Doab Canal has been given to Mr. Conville, late of Volkart Brothers, on condition that he should grow 400 acres of American cotton every year for seed. A proposal to grant a similar lease of 7,500 acres on the same canal to the International Federation of Cotton Spinners on condition that they use the land as a model plantation of American cotton is under consideration of the Local Government. Besides American cotton, attention has also been paid to indigenous varieties, and already some types have been selected for growing on experimental farms to see if any of them is better than the mixture grown by the ordinary cultivator.

In Burma, the study of cotton has now been taken up seriously by the Department on the experimental farms and seed farms are to be established in the districts of Pakoku, Myingyan and Thayetmyo. A combine has been formed between some leading ginning firms of the district to regulate the prices of cotton, and it has had a good effect not only on the prices realized by the cultivators but also in checking the water-

ing of seed cotton by the brokers and middlemen. A movement is also in train to make use of the co-operative organizations in the cotton tract for the purpose of formation of co-operative ginneries so as to assure the supply of pure seed to cultivators.

It will thus be seen that much has been done in various provinces in the matter of improvement of this important crop and there are prospects of considerably more being done in the near future. But there are certain difficulties in the way of establishing a permanent improvement and they must be overcome before substantial results of value can be achieved. The greatest difficulties are those which arise in the organization of seed distribution, in the supply of pure seed, in the prevention of adulteration both in seed and lint and in the building up of a confidence on the part of buyers and spinners, and the Agricultural Departments have constantly met with these difficulties in their efforts. One method of dealing with these difficulties appears to be to concentrate efforts in a comparatively small area and to establish there a large Government Seed Farm with its own ginnery for demonstration as well as for supply of seed. Suitable Agricultural Unions can then be formed round the Central Farm and if the members undertake to grow improved cotton only and to gin it themselves it is possible that the cotton crop in the area in question will be entirely replaced by a new kind in a few years and the area will then have built up its reputation as a producer of an improved kind. The operations can then be transferred to other tracts. The success attained in the Central Provinces is an excellent example of what can be done by concentrating efforts on one object and work on similar lines in Bombay, Madras, and the United Provinces is also beginning to show practical results. In short the whole work may be summed up as primary concentration on a few places to be followed by ultimate radiation of the results from those places over an ever-widening area outside.

(*c*) **Wheat.**—The work of improvement in cultivation and the distribution of pure seed of selected local types has been continued in the wheat growing provinces. The outstanding feature is the progress of some of the types isolated by the Howards at Pusa. Pusa No. 12 especially has invariably

given satisfactory returns both as regards yield and quality in almost every district from Gurdaspur in the Punjab through the United Provinces to Bhagalpur in Bihar and also on the black soils in Bundelkhand and in the Central Provinces. "Pusa 12" is a white wheat with smooth, red chaff and long ears which are without awns. In the field it is an attractive looking wheat and the typical red ears and smooth shining straw are characters of value in the work of replacing the country wheats by a new kind. The grain has excellent milling and baking qualities, which are not lost when the wheat is grown under varying conditions and is suited both for export and local consumption. It has been distributed to a large number of cultivators in Bihar, the United Provinces, the Punjab, and the Central Provinces, and everywhere it has attracted notice.

The distribution of this wheat to cultivators is now being actively taken up by the Agricultural Departments of the United Provinces, the Punjab, Bihar and Orissa and the Central Provinces, and all the available supply, which was far below the demand especially in the United Provinces, has been distributed. A large amount of seed is required for the purpose of starting the various seed distributing organizations now being built up by the Agricultural Departments. As any wheat grown under Indian conditions tends to become impure both on account of natural cross-fertilization and accidental mixture, it will be necessary for the various distributing agencies to secure from time to time fresh pure stocks, until the wheats in any locality have been replaced entirely by the improved kind when the new variety can be left to maintain itself. To provide such a large amount of supply, arrangements have been made by the Imperial Economic Botanist to utilize some of the indigo estates in the neighbourhood of Pusa as seed farms for the growth of large quantities of seed of the new wheats. Every care is taken on these estates to attend to proper cultivation and to keep the varieties pure, and from time to time, the various kinds grown there, are started afresh from a new stock of selected seed grown at Pusa. In 1914, 2,500 maunds of seed of Pusa 12 were disposed of long before harvest time and it is expected that in

1915, about 10,000 maunds which should be sufficient to sow about 10,000 acres will be available. A beginning has been made during the present year with the co-operation of Mr. Burt, the Deputy Director of Agriculture, in the work of growing sufficient seed of Pusa 12 at a few centres in the Central Circle of the United Provinces so that the surplus can be sent as a special shipment to England to establish its value on the Home markets. By taking advantage of the development of the co-operative movement in this circle, it is hoped to replace systematically, from certain centres, the country wheats by Pusa 12 over large areas. This wheat has also been largely distributed in some Divisions of Bihar and it is hoped that a considerable centre will be established for it at Nawadah, Gaya, where members of co-operative societies have been convinced of the value of the new seed. When placed on the Calcutta market it fetched four annas a maund above Bihar wheats on its appearance alone.

The fourth generation of the crosses between Indian and English wheats referred to in the previous report has yielded material for selection for further growth of a large range of individuals, all of which are characterized by strong straw, rust resistance and attractive looking grain. Some types will probably be fixed in 1915, after which they will be tried in wheat growing tracts.

(*d*) **Tobacco.**—The only progress with regard to this crop worth mentioning is that made in the investigations at Pusa. The cigarette tobacco known as type 28 referred to in the previous report is being grown on a good many of the indigo estates in Bihar, and its yield under estate conditions is very satisfactory. It is also being taken up by cultivators for the local trade, and arrangements have been made to grow at Pusa sufficient seed for distribution so that the variety can be maintained true to type.

It has been found that by partially sterilizing the seed beds, the seedlings grow faster and stronger and are ready for transplanting earlier than when grown in the ordinary way—a subject of importance for Bihar conditions—and work is in pro-

gress with the object of devising a most economic method of adapting these results to estate conditions.

Interesting results were obtained during the year on green manuring for tobacco with *Sanai* (*crotalaria juncea*), emphasizing the importance of time in ploughing in the green crop. It was observed that until a certain stage is reached in the decay of a green manure crop, it is quite possible that the want of oxygen and excess of carbon dioxide (which Kidd has shown to be produced by the decay of green manure in such a quantity as to inhibit the germination of seeds) would be limiting factors to succeeding crops, and the absence of any marked crop increase on the heavy lands in Bihar, which receive a dressing of *seeth* or are treated with green manure, is probably due to such conditions. Researches in this connection will be of considerable interest.

Observations on the inheritance of characters in *Nicotiana rustica* L. by Mrs. Howard were brought to a conclusion during the year and a paper is in preparation.

(*e*) **Sugarcane.**—A considerable amount of work is being done by Dr. Barber at the special Cane-breeding Station at Coimbatore in connection with the classification of canes and the evolution of improved types suitable for different localities. The large number of seedlings raised on the station were critically examined with the object of studying their inheritance of agricultural, chemical and morphological characters. Great variations were found to exist among the canes raised from seed, thus giving rise to the prospect of success in this work. Chemical analysis has shown that some of the canes contain over 19 per cent. of sucrose and more than 50 seedlings were found to possess over 17 per cent. The idea is to send the canes which are promising, to the farms in North India for trial. Dr. Barber is also engaged in crossing the hardy North Indian canes with South Indian canes containing a large percentage of sugar and this work promises to be of special interest.

Some interesting factors relating to sugarcane varieties have been investigated by Mr. Somers Taylor at Sabour, which are likely to prove of great use in valuing canes and in decid-

ing between the merits of different varieties. These relate to the effect of the character and quantity of fibre on the amount of juice retained in the bagasse and the relation of the potash content of different varieties to the sugar content of their juice. Details of these investigations have been published respectively in *Pusa Bulletin No. 37* and in an article in the *Agricultural Journal of India* for July 1914.

Apart from research work which has for its object the collection and isolation of pure cultures of indigenous varieties under chemical control and the investigation of their milling properties with a view to the ultimate selection of the most suitable for general cultivation, work of a more utilitarian nature from a local point of view such as the testing of varieties likely to be suitable to the neighbourhood and investigations into the systems of manuring and cultivating is being pursued on the district farms of various provinces. Thus, in Madras, Red Mauritius continues to give good results and its area is extending in South Canara where the Department is also demonstrating the use of iron mills and improved furnaces for *gur* making. The East India Distilleries Co. are trying the picked varieties on a large scale.

The Assam Department makes steady progress in the extension of the cultivation of improved varieties, all of which have been found to give good yields on the Jorhat Farm, one cultivator obtaining from the variety supplied by the farm a net profit of Rs. 151 against Rs. 23 obtained from an equal area of the local variety.

The land for a sugarcane station in North Bihar has been selected and it is hoped to get it into working order soon.

It has been found that selected varieties of thick canes can be grown in the United Provinces, given proper cultivation and irrigation, but their extended cultivation will depend upon the demand, which will no doubt occur, as from the manufacturing point of view these canes are much cheaper and easier to work, and also have a higher sucrose content and give a heavier crop than the *deshi*. Meanwhile selection is being instituted among the local varieties, some of which have already shown marked

superiority in definite areas where the extension of their cultivation is being encouraged.

On the Sindewahi Farm in the Central Provinces excellent results were obtained by growing cane in the month of October, an encouraging feature which will enable a factory (which it is hoped to start shortly) to prolong the crushing season for its cane. An area commanded by a tank in the district has been granted by the Local Administration on certain conditions to Mr. McGlashan of Cawnpore with a view to starting a cane factory.

In Burma the Government have promised to meet half the cost of experiments to be carried out by a Rangoon firm in sugarcane cultivation in the Môn canals area under the supervision of a Java Expert.

On the mechanical side Mr. Hulme, the Sugar Engineer, has done much valuable work in the investigation of the most suitable plant for the manufacture of sugar in Upper India. His first enquiries showed that for sugar manufacture small plants were unlikely to prove satisfactory and attention was therefore directed to the encouragement of pioneer sugar factories on a large scale. Assistance was therefore given to a large factory in Pilibhit which was remodelled under Mr. Hulme's supervision with the result that it has worked very satisfactorily and has produced sugar suitable for the native market. Thus the association of the Department with this factory has dispelled the prejudice against factory-made sugar, and prices in advance of those obtained for Java sugar are now realised for the product of the factory. Similar assistance has also been given to another large factory at Tamkohi which commenced working last year. Provision has also been made to train Indian sugar engineers in these factories.

The Bihar central factories had a successful working season and there are prospects of a satisfactory crop this year.

In Kamrup several areas of 10,000 acres have been discovered which are suitable for working with steam tackle. An area of 23 acres was planted in order to provide material next year for the proposed steam tackle experiments in the growing

of sugarcane. If successful, the results will be brought to the notice of capitalists who are likely to erect an up-to-date factory dealing with 2,000 acres of cane. It is estimated that there is ample space for a number of such factories in the tract.

Side by side with the attempts to improve the white sugar industry, attention has also been paid to the improvement of *gur* and jaggery industry. Mr. Hulme has devised a small plant suitable for cane crushing and a model *gur* making plant has been installed at Nawabgunj in the Bareilly District. At the Shahjahanpur sugar station Mr. Clarke, the Agricultural Chemist, carried out interesting experiments with regard to the efficiency of the small iron mills at present in use in India. The results have been published in *Pusa Bulletin No. 42*. They show that if mechanical power could be introduced at suitable crushing centres, a large amount of bullock power could be released for agricultural work and for extending the area under cane which is limited by the cattle power available for crushing. It is therefore proposed to introduce a system for cane crushing and *gur* manufacture at a central site in villages. Similar work is also being done in Mysore by Mr. Chatterton who is demonstrating the possibility of successfully working small power-driven crushing plants combined with improved furnace for *gur* boiling. His plant consists of a power-driven mill for crushing and sets of open pans for boiling the juice arranged in series as a cascade on an improved furnace which boils down the juice using the megass alone as fuel. The system of working adopted was to invite the ryots in the neighbourhood of the experimental plant to bring their cane to the mill where it was crushed and boiled down to jaggery. The ryots took back the jaggery, paying from 4 to 6 annas per maund of 24 lbs. to cover the cost of manufacture. The results were very successful and it is estimated that with a capital of Rs. 12,000 in an area where sugarcane cultivation is concentrated, about 1,800 tons of cane (produce of about 90 acres) can be dealt with, leaving a profit of Rs. 1,000 per season after deducting working expenses, interest and depreciation. Smaller plants suitable for individual owners or associated *rayats* can be installed for Rs. 2,500.

The use of improved furnaces and more economical crushing mills is also being successfully demonstrated by the Bombay Department of Agriculture who in a recent bulletin have recorded progress so far made. There are now at least 10 power cane crushers at work in the Presidency and the number is sure to increase as the advantages are so obvious.

Other sources of sugar.—Mr. Annett is doing important work in Bengal in connection with the date palm sugar industry, for the development of which there appears to be a possible opening in some of the districts.

Experiments with sugar-beet in Peshawar have given very promising results, and Mr. Leather's investigations show that roots of good manufacturing quality can be grown there in sufficient quantity to supply a factory from the middle of March until the end of June. He has also found that sugarcane can be preserved in good condition in *clamps* over the months of February and March in the Peshawar valley, so that any factory starting to deal with both sugarcane and beet will have a long season of working over six months from December to June. The next step will be to persuade the Zamindars to grow small experimental fields of sugar-beet in order to ascertain whether they can do this readily and at what cost, as beet sugar can only be extracted in a factory and such a factory cannot be started unless a sufficient supply of roots is assured.

(*f*) **Oil-seeds.**—*Groundnut.*—The cultivation of this crop is assuming considerable proportions especially in the Bombay Presidency, where the area has risen from 57,000 in 1903 to 181,000 acres in 1913. This is due to the outstanding success obtained by some of the foreign varieties which have not only supplanted the indigenous variety as an irrigated crop in most tracts, but have also spread largely into areas with no irrigation facilities.

In the United Provinces, groundnuts were introduced into cultivation 8 years ago and there are now about 35,000 acres under cultivation. The crop is at present grown entirely for eating purposes and there is no export trade.

In Madras, groundnut has for a long time been of commercial importance but the Department's efforts at introducing the

crop in some parts and in the distribution of better seed of new varieties in others have resulted in an enormous increase of the area under cultivation as will be seen from the following figures :—

	Acres.
Average of 10 years preceding 1905-06 . .	266,000
Area in 1905-06	393,100
Area in 1913-14	1,175,200

Complaints have, however, been received as to a steady deterioration in the percentage of oil, and more attention will be paid to the crop, although on the Palur Agricultural Station it has been found that by proper rotation neither is the yield decreased nor the oil content deteriorated.

Similar efforts on the part of the Burma Department of Agriculture have resulted in an increase of the area under this crop from about 80,000 acres in 1906-07 to 240,000 acres in 1913-14.

Apart from its paying qualities groundnut is an excellent rotation crop as it produces a beneficial effect on the soil. On the Tharsa Farm in the Central Provinces, wheat grown after groundnut gave a very high net profit of Rs. 109 per acre. The chief difficulty, here as well as in many other localities, which prevents its rapid growth is the damage done to it by crows, jackals and wild pigs.

Coconut.—Work on coconuts is at present confined in Madras to combating disease and in Bombay to a study of local conditions and practice. In the latter place the nuts are all consumed locally, and the export trade is not so important as on the Malabar coast. The Madras Department of Agriculture propose to take up further work as soon as sufficient staff is available. In view of the growing demand for copra from which vegetable butter is made the cultivation of this crop is likely to assume increasing importance.

In Travancore, where the crop yields more than 70 per cent. of the total customs revenue of the State, work is in progress to find out the effect of systematic manuring on the yield of coconuts, and the study of the characteristics of the different varieties has been taken up.

(*g*) **Tea, Coffee and Rubber.**—The steady increase in the area, production and export of tea is a clear indication of the progress made in this crop. In 1913, there was an increase in area as well as in production of about 3 per cent. over the preceding year, while the exports improved by 4 per cent.

The Scientific Department of the Indian Tea Association, towards the maintenance of which an annual subsidy of Rs. 15,000 is made by the Government of India, continued researches on problems affecting the quantity and quality of tea, including the control of pests and diseases. A series of experiments was carried out at the Tocklai Experiment Station with the object of determining the influence of manures on the growth of tea seedlings and a chemical investigation was begun with a view to find out the factors which influence the quality of tea. The question of manuring is now receiving a good deal of attention on many tea estates in North India, but any extended use of artificial manures is limited by the availability of labour which is hardly sufficient even to maintain proper cultivation under ordinary circumstances. Green manuring, however, is expected to receive increased attention as it is cheaper than chemical manures and requires less labour for a given result. In an actual experiment on one of the estates in Darjeeling, an increase of 70 lbs. of tea per acre was obtained by green manuring. In connection with mosquito blight, it has been ascertained that in general a definite relationship exists between the ratio of available potash and phosphoric acid in tea soils and the prevalence or otherwise of mosquito blight, and research is being continued on these lines. A systematic study of life-histories of chronic fungus diseases which are believed to cause a loss of at least 10 lbs. of tea per acre over the whole of tea districts in North-East India, has been taken up by the Mycologist of the Association. Besides research, a greater portion of the time of the experts is also spent in touring and advising the planters.

In the absence of any agricultural station, great difficulty is experienced by the Scientific Department of the United Planters' Association of South India to conduct under proper control experimental work on coffee and rubber, and Mr.

Anstead, the Planting Expert, has submitted to the Association proposals for the future development of the department in order to make it more efficient and useful. In spite of the difficulties, a few experiments were carried out during the year under report, some with a view to testing the effects of various fertilizers on the yield of these crops and others in the fertilization and hybridization of coffee. It has been found that the system of manuring coffee based on a chemical analysis of the soil and past history of the estate brings on very good results, and many estates are adopting such a system.

Mr. Fletcher, when Entomologist to the Government of Madras, carried out a series of experiments to determine the part played by bees in the pollination of coffee. The results are not very conclusive but they show that a considerably important part is played by the large rock bees, *Apis dorsata*, in this work.

The Green Scale (*Lecanium viride*) which has proved such a serious coffee pest in Ceylon and Southern India has invaded the coffee estates in Mysore and Coorg. This insect causes great injury to the plant by sucking its juice and in some places such as parts of the Nilgiris where the attack was most severe it has destroyed the entire coffee-bushes and brought about the abandonment of whole estates. Although in Coorg and Mysore the Scale was first noticed about a year ago, it has now spread throughout North and South Coorg, and in Mysore, about 67 estates have been found to be infested. It has therefore attracted the serious attention of the coffee planters as well as of the Scientific Departments concerned. No practical means for the actual extermination of the pest have yet been found but efforts are being made to keep it under control by the application of a contact insecticide. In May 1914, the Imperial Entomologist visited Coorg, saw the affected areas and advised the planters on the subject.

(*h*) **Indigo.**—The investigations on indigo carried out by the Howards at Pusa, to whom this work was entrusted after the closing of the Sirsiah Station in 1913, have yielded very valuable results. The diseased condition of Java Indigo, known

locally as *wilt*, which has brought about the reduction in the area under this variety in Bihar from 70,000 bighas in 1910 to 15,000 bighas in 1913, and to which the causes of the non-success of the Sirsiah experiments with Java Indigo have been attributed, has been found by them to be due to a long continued wet condition of the soil which destroys the feeding roots. It was found that if Java Indigo is sown for seed early in August on well drained land in good condition, the diseased condition is avoided and good crops of well-developed seed are produced. These results have been repeated under estate conditions and it would thus seem that one of the chief causes of the decline in the area under this crop has been removed.

Besides the seed supply, other aspects of indigo improvement have also been investigated by the Howards and some results of practical interest have already been obtained. These have been published in detail in the Report on the Improvement of Indigo in Bihar made to the Bihar Planters' Association, and also in the Botanical Section of the last Report of the Pusa Institute. On the whole, the general experience with this crop at Pusa indicates that a considerable amount of improvement can be made in the production of indigo, and the work on the subject is being continued.

(*i*) **Fruit.**—With the exception of the fruit work at Pusa and Quetta the subject of fruit-culture has scarcely received the attention on the part of Agricultural Departments in India which it deserves. The question is no doubt of more or less importance in all provinces but it is largely dependent upon whether there are good markets for the sale of fruits in each province where they are grown. Further, the paying nature of a fruit crop compared with the extent of ground covered would appear to call for larger attention to be devoted to it than has hitherto been the case. In order therefore to elicit opinions on this point from the experts of the Provincial Departments the subject was put up for informal discussion before the last meeting of the Board of Agriculture who recommended that in Provinces where the fruit trade is considered of sufficient importance to justify an extension of the Departments' activities in the direction of fruit investigation and where the subject

is not being dealt with at present, a preliminary investigation should be made.

Fruit-culture is at present of great importance in North-West India where considerable attention is being paid to the improvement in cultivation and packing and transport. At the Saharanpur Botanical Gardens a new area has been planted up in fruit trees, about 464 varieties of various kinds being grown. Attention has also been paid to fruit-bottling and successful trials have been made with various fruits. A local zamindar has been interested in the matter and he proposes to take it up on a large scale. Owing to the influence of the Gardens, Saharanpur has now become a centre of fruit industry, and the situation is likely to prove very favourable for demonstrating improved methods of growing and packing.

In the Punjab Mr. Milne is engaged in the study and improvement of date palms and has succeeded in growing superior varieties imported from Arabia. Attempts are also being made by Mr. Mitchell of Kashmir to bring portions of the Western Punjab hills under olive cultivation.

The success attained in fruit-growing in Peshawar has already been noted in Part II of this report. Before the establishment of the Government Farm in the North-West Frontier Province, peaches were grown from seed by the zamindars and the introduction of budded stock has therefore heralded a great improvement. Nearly 50,000 budded peaches have been distributed by Mr. Robertson Brown, the officer-in-charge.

Considerable attention has been paid by Mr. Howard to the development of the fruit industry in Baluchistan and progress has been made in the laying out and equipment of a Fruit Experiment Station at Quetta. He has demonstrated improved methods of packing and transport of fruit in India, and the packages designed by him for the purpose have been taken up in large numbers during the last two years. He submitted a paper on cold storage of fruit on Indian Railways for consideration at the last Railway Conference and the question is under consideration of the authorities.

Attention is also being paid to fruit cultivation by Mr. Burns in Bombay and Mr. Henderson in Sind where grapes, peaches and oranges have been found to do well, while in the Central Provinces the possibilities of several suitable tracts for fruit-growing are being investigated.

As there are indications of European fruit trees being grown successfully in Khasi hills, the Assam Department opened a Fruit Experiment Station near Shillong in 1912 and the experiments made so far show great promise of the ultimate success of the undertaking.

2.—*Special Subjects.*

(*a*) **Agricultural Education.**—The subject of Agricultural Education was referred to the Board of Agriculture for consideration at its meeting in December 1913 as there was general dissatisfaction with the three years' diploma course as prescribed by the Board in 1906, and amended in 1908. The Board emphatically condemned the uniformity in syllabus and diploma imposed on the Provincial Agricultural Colleges by the resolution of 1906, and passed resolutions the trend of which was to the effect that the various provinces should be free to work out systems suited to their local conditions, and that it was advisable to have both a practical course and also a more advanced course for those capable of following it, as it was hopeless for agricultural education to develop far in advance of the experimental work on district farms and of the knowledge of the districts. Giving effect to these resolutions, a two years' preliminary course to be followed by a more advanced course of 18 months has been introduced in the Coimbatore College (Madras). The first of these courses is to be devoted to agriculture, live stock, dairying and horticulture, practical and theoretical, with particular stress on the agricultural aspect in every case. The course is complete in itself and is expected to be adequate for the intelligent management of their own land by those students who intend to become practical farmers and for the training of agricultural assistants. The further course will be devoted to more detailed

work on the sciences underlying agriculture. Only a portion of those who successfully pass through the first course and are capable of following the advanced course will be admitted to it, and on successfully completing the full course, they will be awarded the diploma of L.Ag. Under the revised scheme 43 students have been admitted into the College during the year under review.

A new course divided into two parts, each of two years' duration, has been introduced in the Agricultural College at Lyallpur (Punjab) on lines somewhat similar to those of the Coimbatore College. The entrance qualification for the preliminary course at Lyallpur is higher than that at Coimbatore, *viz.*, the entrance examination of the Punjab University. Only 11 students have been admitted into the College.

Ten students took admission during the year into the Sabour College but none of them belonged to the province of Bihar and Orissa. A scheme is being worked out for the revision of the College curriculum so as to provide for a two years' preliminary course.

In the United Provinces, a separation of the *Kanungo* students from the Agricultural College at Cawnpur has been effected: a separate school being established for candidates for *Kanungoships*. Henceforth there will be two courses at the Agricultural College, the one of which will be of two and the other of four years' duration. In the two years' course the instruction will be given in Hindustani and will be of a practical character. The course will consist mainly in the teaching of agriculture in its different branches besides dairying, care of cattle, veterinary practice, agricultural entomology and agricultural engineering. The L.Ag. or four years' course will be taught in English and will consist of instruction, practical and scientific, in agriculture and its allied subjects as well as in rural economy and the technique of co-operation. It is also intended to start small classes of six or eight months' duration for a third class of students, *viz.*, sons of large occupancy tenants, on some of the demonstration farms of the Agricultural Department.

In the Nagpur College (Central Provinces) the number of candidates admitted during the year under review was larger than in the previous year. The college curriculum has recently been altered in the direction of concentrating Chemistry and Botany in the first two years, while more attention was paid to Agriculture, Veterinary Science and Engineering in the third year. Though this arrangement is reported to be giving promising results the necessity of imparting a thorough practical knowledge of agriculture and its leading principles and of such subjects as surveying, veterinary science and engineering to students of the agricultural castes from whom it is intended to draw men for the lower subordinate cadre of the Department, but, whose deficiency in English makes them unable to take advantage of the existing course, has to be met. A modification of the College curriculum in the light of the recommendations of the last Board of Agriculture is therefore in contemplation.

In the Bombay Presidency, the Agricultural College at Poona whose course leads to a University degree continued to maintain its standard of efficiency. The fact that it turns out some 20 agricultural graduates every year and some 15 students who have been put through a practical course of one year in order that they may fit themselves to manage their own property cannot fail in time to make its usefulness felt on the agriculture of the Presidency. The Vernacular Agricultural School at Loni continued to improve and is in a flourishing condition. The boys receive a practical two years' course in agriculture while their general education is continued with an agricultural bias. This course broadens their out-look and thus enables them to appreciate the possibilities of agricultural progress and the directions in which it may be secured. A similar school in Sind has now been opened for two years and is doing well. A Kanarese School has recently been opened at Devihosur, while one for the Gujarati-speaking people is under construction at Godhra. The popularity of these institutions is proved by the fact that the inhabitants of Chopda in Khandesh have collected money for the establishment of an agricultural school in that locality; a gentleman in the Konkan is providing funds for the establishment of a school in the

Thana District and another gentleman has established a school at Alibag in the Kolaba District at his own cost and under his own supervision.

The Agricultural School in Mysore has now 28 students, 14 in the first year and 14 in the second year. Most of these students are reported to have done well in theoretical and practical agriculture and to have taken up the manual work connected with the agricultural science in an enthusiastic manner.

The training of students in post-graduate courses was continued at Pusa and short courses were also given in cattle management and sericulture. Besides one private student preparing for the D.Sc. degree, Allahabad, who worked in the Chemical Laboratory for eight months on a piece of research, four regular students were under training in Agricultural Chemistry, two in Entomology, one in Agricultural Bacteriology and one in General Agriculture during the year under report. Seven students attended the short-courses—one in Cattle Management and six in Sericulture.

(*b*) **Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures.**—Much progress has been made under this head during the year under report especially in the careful adaptation of methods to local conditions, and in the founding and pushing forward of co-operative organizations which are proving their use in the work of bringing improvements both to the notice and into the practice of the cultivators. The direction in which most development has taken place so far is in co-operation for the production and distribution of seed but societies have also been formed for the purchase and distribution of manures and for dairying and cattle breeding purposes, as will be seen from the Section on co-operation below.

In Bombay, many Agricultural Associations both sell and hire out iron ploughs and various co-operative societies keep them for the use of their members. The introduction of these ploughs has made a very striking progress and they are in demand by thousands. Some of the credit societies have been the means of introducing to their members Cambodia

cotton and groundnut, while others have undertaken to grow seed of *roseum* cotton supplied by the Department and to keep it pure for their own use. For this type of cotton for which there is a great future in Khandesh, the Department has a big seed farm and various seed growers scattered round it. As a result of the local demonstrations which occupy a large part of the time of the Department, the benefits of steeping Jowar against smut, storing of farmyard manure in pits, green manuring and application of nightsoil have been brought to the notice of large numbers of cultivators. Some of the demonstrations on the Government Farms were largely attended last year by groups of cultivators from various parts, and a selected party was taken round some tracts to show the benefits of advanced cultivation. The use of sulphate of ammonia for sugarcane and irrigated potatoes is spreading and a large manure supply society has been promoted in one of the sugarcane tracts in the Deccan. There are 56 Agricultural Associations and attempts are being made to bring them into closer touch with the Department and its officers.

In Madras, most of the improvements so far brought about have spread from District Farms through the efforts of trained men placed in the villages to demonstrate some definite improvements in definite areas. This local work is supplemented by a widespread distribution of agricultural literature and leaflets in all vernaculars, and instances have come to notice in which improvements have been adopted by men in tracts never visited by agricultural officers, by following instructions thus published. The introduction of the seed drill and harrow for cotton cultivation in Tinnevelly is the result of steadily persevering in these methods. These implements are now in use in 80 villages and in 1913-14 about 7,000 acres were actually drilled. Similarly the practice of single seedling transplantation of paddy and green manuring for wet lands is rapidly spreading, 120,000 lbs. seed of green manure crops being sold by the Department during the year.

So far very few Agricultural Associations in Madras have been of much use to the Department, principally owing to want of any interest in agricultural improvement on the part of

their members. The Department is therefore making a trial by organizing village associations composed of members interested in agriculture who undertake to try a definite improvement. Twenty-three such associations were organized in Malabar during the year for the economic planting of paddy and 20 of them have worked well. Eight agricultural co-operative societies have also been formed for joint purchase of manures and for raising and maintaining pure strains of cotton and selling the produce jointly. A steady demand has arisen for iron crushing mills in some districts and for iron ploughs in others, while there are great prospects of fish manure being adopted for crops under wells. Last year orders for 20 tons were registered. This manure is at present largely exported to Ceylon and Japan.

In the Central Provinces, co-operative organizations for the production and supply of seed are coming into increasing prominence, and the connection between the Department and the cultivators is maintained by two different methods, *viz.*, co-operative organizations where they are strong and Sub-Associations of District Agricultural Associations where this is not the case.

The demonstration work in Chhattisgarh has resulted in the adoption of the method of transplanting rice in nearly 4,000 villages. The advantages of transplantation have been made obvious by ocular demonstration, and crop cutting experiments carried out in 52 villages showed an average increase of 981 lbs. of paddy per acre in favour of this method. Large quantities of seed of wheat, cotton, *til* and groundnut were distributed in this way in definite areas. The single seedling transplantation of rice was demonstrated in areas protected by Government tanks in the Nagpur Division and 16,000 lbs. of a heavier yielding variety of paddy were distributed.

The sale of implements is being handed over gradually to co-operative bodies, many of whom now stock implements and spare parts for the use of its members.

In the United Provinces, intimate relations are being developed with local bodies such as district boards, co-operative

societies and influential landlords for furthering the work of the Department in matters of demonstration and seed distribution. Four of the larger Central Co-operative Societies have opened seed stores and are undertaking, in conjunction with the Department, to introduce selected varieties of seed among the members of the Societies. Large quantities of wheat seed were in this way distributed during the year.

In the Eastern Circle where much of the land is held by large estates, 40 private farms have been opened with the object of raising improved seed, and familiarising cultivators with the growing of more profitable crops and the use of improved seed and practices. Improved methods of cultivation such as hot weather ploughing and deep sowing of maize were demonstrated on the Government farms and the practices are spreading. Similarly, methods of potato storage have been successfully demonstrated and at one of the principal centres, a co-operative society of potato growers has been organized to store potatoes on a large scale. Some 5,000 maunds were stored during the year under report and it has been shown that a profit of Rs. 3-12 a maund can thus be realized.

In the Punjab, owing to want of staff, demonstration work could not be extended beyond a few districts where Agricultural Associations are reported to have done useful work in demonstrating improved methods. In the matter of seed multiplication the policy has been to select large land owners for growing seed under the supervision of the Department and selling back the seed, if suitable for issue, to the Department at a small premium over the market price. Large quantities of wheat of different types including Pusa 12 suitable for different tracts were in this way grown last year by members of co-operative banks on seed farm conditions. But in order to free the Department from selecting and taking over for issue large quantities of seed at harvest time from such growers and from the necessity of making arrangements for separate ginning of the *kapas* in case of cotton, efforts are being made to start co-operative organizations constituted for the special purpose of raising and distribution of seed.

In the remaining provinces the work of bringing improved seed or practices to the notice of cultivators is done through Agricultural Associations and Honorary Associates (in case of Assam) and by local demonstrations on cultivators' plots and at agricultural shows and fairs. A central seed store is maintained by the Departments for supply of seed and implements.

In Bihar and Orissa, the method of storing potatoes in sand to keep the potato moth under control is being largely taken up in the Patna Division where during the year 122,000 maunds of potatoes were stored in this way by 1,500 cultivators, of which 66,000 maunds were saved. Pusa wheat was successfully grown by various members of Agricultural Associations and by cultivators and there is a large demand for it. Meston ploughs are being taken up and the use of green manuring is spreading in various localities. The results of the campaign against "Greasy surface caterpillar" on *rabi* crops have already been referred to in Part II.

In Bengal, the beneficial effects of bonemeal on paddy were demonstrated on 551 plots in three divisions which resulted in a considerable increase of outturn in a majority of cases. About 12 tons of bonemeal were distributed from the seed store during the year. Similar demonstrations were also given in the conservation of cowdung and in seed selection of jute and paddy. The problem of utilizing co-operative credit societies for furthering the work of the Department is engaging attention.

In Assam, demonstrations with superior varieties of cane and with iron mills for crushing were continued in some districts with great success. The demand for iron mills is increasing, one man in Kamrup having asked for 50 mills to let out on hire. In the Khasi hills, the use of bonemeal and cultivation of better varieties of potatoes are increasing. About 900 maunds of potato seed were sold during the year in these hills and six temporary seed depôts have been started for future supply. Attempts are being made to bring about a closer connection between the work of the Department and co-operative societies.

A striking testimony of the success of local demonstrations in controlling pests and diseases comes from Mysore. The efforts in stamping out the disease (*Koleroga*) of the betelnut palm by spraying have been so successful that various garden owners are now co-operating with the Department for similar work. Demonstrations were also given in efficient measures for the control of an important pest known as Kumblihula (*Amsacta albistriga*, Wlk). The services of the village children were utilized for collecting the moths of the insect so that the expense to the cultivator was very small. Such efforts for the last two seasons have resulted in a complete destruction of the pest in some parts.

Successful results have also been obtained in this State in demonstrating the value of improved cotton and sugarcane varieties, the use of oilcake for sugarcane, the improved methods of jaggery boiling, the use of green manuring and single seedling transplantation of paddy, and of iron ploughs. Four hundred and forty-six iron ploughs were sold during the year in 8 districts. The demonstrations have so far mostly been made by Agricultural Assistants who are stationed in every district, but successful attempts have also been made towards getting into touch with local organizations with the object of arousing the interest of the members in the work of the Department.

(*c*) **Agricultural Engineering.**—Considerable progress has been made under this head during the year under review. Mr. W. M. Schutte held the post of Agricultural Engineer in Bombay, Mr. F. H. Vick in the United Provinces and Mr. T. A. Miller-Brownlie in the Punjab. In the Madras Presidency work under this head is in charge of an independent officer—the Director of Industries. Other provinces have not yet got Agricultural Engineers on their staffs.

With the object of studying the economics of steam cultivation and to overcome labour difficulties, a Fowler's double-engine steam cultivation tackle was obtained for Pusa in September 1913, with a disc plough, cultivator, harrow and roller. Another plant has also been obtained for a lessee of 2,000 acres on the Lower Bari Doab Canal in the Punjab to whom the lease

has been given on condition that he cultivates the land by Fowler's double-engine system of steam ploughing. In the Madras Presidency, Messrs. Parry & Co., successfully ploughed, harrowed and trenched their sugarcane land at Nellikuppam by means of steam tackle. Success has also been obtained in the Bombay Presidency in a trial with steam tackle. It ploughed 750 acres of foul land to a depth of 15 inches for Rs. 21 an acre and paid its working expenses, charges for depreciation and 6 per cent. interest on capital outlay.

In the canal-irrigated tracts of the Punjab, reapers have been found to be a most economical machine as the cost of reaping an acre is reduced by Rs. 3-8 to Rs.5-8. In all, 153 reapers have up to this time been sold to zamindars to whom every assistance is given in repairing and overhauling the machines before harvest.

There are 24 power-driven ginning plants at work in Berar (Central Provinces) where it was decided by a Committee of the Divisional Association that it is absolutely necessary for every Seed Farm Union to possess its own oil-engine and gins. Many of these engines are also used for running fodder cutters and flour mills. There are 22 agencies for the sale of implements in the Berar Division, some managed by co-operative bodies and some by members of the agricultural association. Implements valued at Rs. 40,000 were sold during the year by the Department in the Southern Division. In the Northern Division a plough useful in the eradication of *Kans* grass is much in favour and about 400 of them were sold in 1913-14.

Considerable progress is reported from several provinces in the matter of boring wells. In the United Provinces, the Department has for some years past been making efforts for improving the water supply of existing wells, in the areas unprotected by canals, by borings to deeper water-bearing strata. Since 1906 about 9,000 wells have been bored, success being achieved in nearly 6,000 cases. The services of the well-boring department are freely placed at the disposal of zamindars and others desirous of undertaking well construction or the improvement of existing wells, and through the efforts of this depart-

ment there has been an increase of 83,000 masonry wells during the last five years. Progress has also been made in spreading the use of power pumping and with the appointment of the Agricultural Engineer this work is expected to develop considerably. Plants have already been installed or are in the course of erection in 31 places and the Department hopes that from actual demonstrations and financial as well as mechanical assistance there will be a large increase in the number in future.

Similarly in the Bombay Presidency pumping plants are coming into use more and more on river banks. The Agricultural Engineer is engaged in designing suitable plants for varying conditions and in advising and assisting owners in their management. There is a workshop for training cultivators in the use of machinery, and an oil-engine has been installed at the Vernacular Agricultural School near Poona to train boys in its use for pumping, and other agricultural work.

Boring work which was until the past year confined to Gujarat has received a considerable impetus owing to the invention by Mr. Musto, the late Agricultural Engineer, of a boring plant which has proved itself a highly efficient one. The efforts of the Department in boring operations have so far added considerably (900,000 gallons per hour) to the irrigation resources of Gujarat and in some parts where the strata are regular, the Department can now guarantee water under pressure almost with certainty at depths of less than 200 feet.

In Bihar and Orissa, there is a special well-boring department in charge of a Superintendent and under the control of the Agricultural Chemist. The work so far done has met with such constant success in the Patna Division that the operations have now been handed over to the District Boards concerned and the energies of the Department have been directed to other Divisions. In all 110 borings were made during the year, most of which were successful. The advantages are fully appreciated by the cultivators and the demand for boring is consequently increasing, while in some places the results have been so satisfactory that the owners are reported to be desirous of erecting small pumping plants.

In the Punjab, well-boring work is going on in 11 districts but its extension is hampered owing to inefficient staff of borers.

(*d*) **Dry-Farming.**—There is nothing definite to report on what might be called dry-farming beyond Mr. Howard's work at Quetta, where the conditions of water in the sub-soil appear to resemble those said to exist in the best dry-farming areas in Western America, and where the rainfall is more or less consistently insignificant. It has been found that by suitable methods of moisture conservation a great saving of irrigation water is possible in Baluchistan. In the case of the wheat crop good results were obtained by giving only one watering before sowing (the usual number of waterings given by cultivators is six to eight), and afterwards conserving the soil moisture by means of a surface mulch produced by lever harrows.

The experiments in other places of moderate but uncertain rainfall have more or less reference to the evolution of standard farm practices which must vary according to local conditions. Thus, in Mysore, deep ploughing and use of the sub-surface packer for consolidating the land have been found to increase the yield of *Ragi* (*Eleusine coracana*) in a season of scanty rainfall, while in the United Provinces hot weather ploughing for wheat effects a saving of water when there is a great demand for it. In the Botanical Section at Pusa the value of hot weather cultivation and proper conservation of soil moisture in improving the yield of crops in Bihar has already been demonstrated. The Departments in India are already aware of the general principles underlying dry-farming, and the matter is largely one of development of improved practices by local demonstration.

In Bombay the experiments made at Ahmednagar in dry-farming have shown that "in a year of moderate rainfall typical dry-farming methods are of distinct advantage in conserving moisture, but that in heavy Black Soil even the most careful cultivation will avail nothing in a 'famine' year." Before studying further the question of dry-farming, it is considered necessary to classify the soils of the East Deccan where the rainfall is very light and to ascertain their physical properties, which make the problem different from

that in the dry-farming regions of the United States of America.

In connection with this subject, Mr. Keatinge's observations on dry-farming in the United States of America are of interest. He says :—

"Other points in which the dry-farming regions of the United States of America have an advantage over us is that the rainfall is far more consistent and better distributed. They know fairly well what rain they can count on, and do not get such excessive downpours in a day as we often get. With us a tract which usually gets less than 15 inches of rain in the year may suddenly get 20 inches in two months, or contrariwise in a famine year a tract may get less than two inches in a year. Further the heat of the sun, and consequently evaporation, is far less in the United States of America, during the greater part of the year; and in the late summer when the heat there is considerable, the crops cover the ground. Last but not least, must be mentioned the fact that they have at their disposal far better teams and far better implements than our farmers have."

In conclusion Mr. Keatinge says :—

"My general conclusions are :—

(1) That we must work out our own problems of dry-farming.

(2) That the study of soil physics is a matter of great importance to us."

(*e*) **Sericulture.**—This industry being of great importance in Bengal and Assam continued to receive a large amount of attention from the Departments in those provinces. The new scheme for the supply of seed-cocoons free from disease to the whole province of Bengal, described in the last year's report, has been modified so that instead of obtaining seed-cocoons from village rearers and eliminating the cocoons which were diseased, the procedure now is to exchange seed between the various nurseries. Branch nurseries have been closed and central nurseries are being brought up to their maximum strength.

M. Lafont, late Sericultural Expert, reported that the attempt to convert univoltine races of silk-worms into multivoltine by acclimatisation was a failure in Bengal, although the attempt was successful in Madagascar. A small nursery has been established at Kurseong with the object of ascertaining whether cross-bred worms, if kept in the hills

from July to October, would maintain the superiority of the first generation over the native varieties.

The system of subsidising passed students of the Berhampur Sericulture Class and of the Rajshahi Sericultural School, in order to enable them to raise model rearing houses, has been continued. There were 17 pupils in these schools, of whom 6 passed the final examination during the year.

Rai Bahadur Bhupal Chandra Basu, M.R.A.C., was placed on special duty to enquire into the present condition of the silk industry in Assam. He has completed his enquiry and his report will be published shortly. The rearing of silk-worms at the Fruit Farm near Umlyngka was carried on by the Roman Catholic Mission who were granted a subsidy of Rs. 1,500 for constructing a new rearing house on the farm. Rai Bahadur Basu, who watched the experiments carried on by the Mission, reported that the Nistary and the Hybrid worms did remarkably well. They kept healthy all through and gave a full yield of cocoons which were of excellent quality.

In the Mysore State, where also the industry is of importance, the Government employed an Italian Silk Expert for one year in 1914 to introduce improved methods of rearing silk-worms. He trained 7 Inspectors and 6 students of the State in the European methods, started a central rearing farm and carried out successful experiments with the Mysore, the Bengal and many Italian breeds.

At Pusa, a multivoltine mongrel race of mulberry silk-worms was established after many trials, and this at first yielded silk superior in quality and quantity to those of the Bengal multivoltine race, but the strain began to deteriorate after the 14th generation. Experiments are being continued to obtain a fixed type. Satisfactory results were obtained from the univoltine mulberry silk-worm eggs sent to Ramgarh (Naini Tal), Muktesar, and Calcutta, for cold storage. Simple and practical directions on the rearing of mulberry silk-worms, silk-reeling, dyeing and weaving have been published in *Pusa Bulletin No. 39* and another Bulletin on suggested improvements in reeling is in the press.

(*f*) **Board of Agriculture in India.**—The eighth meeting of the Board was held at Coimbatore on December 8th, 1913, and the following days, under the presidentship of Mr. J. Mackenna, I.C.S., then officiating as Agricultural Adviser to the Government of India. The field of its activities was widened by the inclusion of representatives from the Civil Veterinary Departments in its membership. The meeting was attended by 49 members, out of whom 10 came as representatives of the Veterinary Service, and 26 visitors. There were 11 subjects down for discussion, which were referred for consideration to Committees whose reports, with the Board's resolutions thereon, are printed *in extenso* in the published Proceedings.

Of all the subjects which came up for discussion, the one which excited the most interest and attention was Agricultural Education. The most important feature of the discussion on this subject was the insistence on the impossibility of having a uniform curriculum and on the necessity of adapting agricultural education in each province to the particular needs of that province. Other points, the importance of which was emphasized, were the advisability of framing a course of instruction of a more practical and less scientific nature, the necessity of close co-operation between the Agricultural and Educational Departments in developing rural education and the advisability of experimenting with vernacular agricultural schools as a means of training the sons of the better class *rayats*.

The consideration of the subject of the Indian Sugar Industry, which formed the chief subject for discussion at the 7th meeting of the Board, was important mainly in that it gave the Board an opportunity to hear of the considerable amount of work done by the Sugarcane Expert, Dr. Barber, and of the action taken by Local Governments on the various recommendations of the Board.

The Dairying Industry of India was a new subject and one in the discussion of which the advice of Colonel F. W. Hallowes, Director of Dairy Farms, and of Mr. W. Smith, Assistant Director, Military Dairy Farms, was of great value to the Board. Perhaps the most important single point in the Com-

mittee's report on the subject was the emphasis placed on the possibility of breeding animals in India for the dual purpose of draught and milking.

The chief points emphasized by the Board in their discussion of the subject of cattle breeding and fodder supply were the dependence of cattle improvement on fodder supply, the necessity for an increase in the staff of the various Departments so that more time may be devoted to the subject of cattle breeding and the importance of investigating existing and other possible sources of fodder supply with reference to their availability and suitability.

(*g*) **Co-operation.**—The development of Co-operation in India may be said to begin with the passing of the Co-operative Credit Societies Act in 1904 and its subsequent progress may be summed up as remarkable in its rapidity. In 1905, 41 Co-operative Societies were in existence while at the time of writing there are over 12,000. In the former year the total capital sunk was about Rs. 54,000 while at the present time a membership of over 600,000 and a working capital of over Rs. 5,00,00,000 bear testimony to the strength of the movement to-day, which nevertheless has as yet touched only the fringe of the vast population it will ultimately benefit.

Eminently satisfactory as this growth may be, nevertheless, in estimating the progress of the movement, it must be borne in mind that mere mushroom growth in the form of additions to the number of Societies, their membership and capital is of little use unless accompanied by steady improvement in financial stability, methods of management and above all in fostering of the public confidence in the undertaking and its potentialities, as in a great scheme of this kind the failure of one society through bad management cannot fail to exercise a most deleterious effect on the minds of members of similar societies all over the country. These essentials are, however, by no means lacking, and the outlook for the future may therefore be described as exceedingly favourable.

There is a general desire to associate the co-operative movement with the technical and economic development of agriculture and this has led to the formation of a small number

of societies for co-operative purchase and sale. The necessity of providing for all forms of co-operation and remedying the defects which had come to light as the result of the working of the Act of 1904 led to the passing of a new Act which came into force on July 1st, 1912. As mentioned in the Government of India Resolution of 17th June 1914 on Co-operation, in no direction is there a wider field for the benefits of co-operation than in the agricultural world. From the first it has enabled the cultivator to grapple with the difficulties caused by lack of available capital and an undeveloped system of rural economy, but during the last two or three years it has also begun to show how it is able to assist all who have any right to the name of agriculturists to win a better living from reluctant soils and treacherous seasons. It has in some provinces provided the means whereby the improved seed of the Agricultural Department can be conveyed from the Government farm to every village over large areas, there to be multiplied a thousandfold. It has enabled the purity of the seed to be maintained and the best price to be secured for the produce. It has placed within the reach of the cultivator cheap manures and implements tested and approved by the Agricultural Experts. It has maintained bulls of superior strains for the improvement of village herds, and last, but not least, it has provided the means by which useful information on agricultural subjects can be placed within the reach of every one.

Since the passing of the new Co-operative Societies Act in 1912 which made it possible for co-operative societies to engage in activities other than those denoted by co-operative credit there has been a steady tendency in the Bombay Presidency for co-operative societies to engage in undertakings of an agricultural nature. A number of credit societies now keep agricultural implements for the use of their members and some societies have been specially formed for definite purposes of agricultural co-operation such as the supply of manures, etc. In the Thana District in particular, a number of such societies have come or are coming into existence. Two Co-operative Dairy Societies have already been registered and several are about to start. A Cattle Breeding Society is now in process

of formation; a successful manure supply society has begun work at Kelva, Mahim, which, with a capital of Rs. 8,000, was last year able to supply its members with castor cake at Rs. 16 a *khandi* when the local price was Rs. 20—facts which speak more eloquently than anything. Two more such societies are being started and there is a demand for still more. A society to buy rice hulling machinery has also been registered. Owing to new municipal regulations made in the city of Bombay it is also likely that a large number of *gaolies* will leave the City and settle in suitable localities outside municipal limits. There will in that case be room for a number of co-operative societies to finance them and organize their operations in supplying milk to the Bombay market. In order that this extension of co-operation may go forward on correct lines and young societies may get the necessary expert assistance, the Government of Bombay have created a temporary appointment of a special officer for a period of six months.

In the United Provinces, very close relations exist between the Agricultural Department and co-operative societies as will be seen from the following extract taken from the Director's report:—

"Four of the larger central co-operative societies have opened seed stores and are undertaking in conjunction with the Department to introduce selected varieties of seed among the members of the affiliated societies. Pure seed is in the first instance issued to the society which undertakes to issue to selected growers and multiply for general issue in the following year. It is intended to distribute the large supply of Pusa No. 12 wheat seed, which will shortly be available, through these societies. In the Central Circle, except in case of Cawnpore-American cotton seed which is being put out on a definite area, the co-operative societies take the bulk of seed of all kinds available. In return for the help so received, the Agricultural Department places inspectors at the disposal of these societies to assist in demonstration, selection of seed, ginning, etc., and gives assistance in marketing produce. The subject of improving water supply on holdings of members is one that engages a good deal of attention of the society managers. Borers are lent to improve the capacity of the wells, and in two instances arrangements have been made to put down power pumping to supply water on a large scale. A number of inquiries on this subject has been received and as the possibilities of supplying water on a co-operative system are realised, installa-

tions are likely to increase in number. Some of the societies are also proposing to keep bulls, as soon as the cattle farms are in a position to supply them."

In the Punjab a few co-operative banks are stocking Meston ploughs for sale.

In the Central Provinces the development of Agricultural Unions, chiefly for seed supply is very encouraging. A full description will be found in a paper on the " Organization of Seed Farms in the Central Provinces " by Mr. Evans in the *Agricultural Journal of India*, July, 1913. In the Northern Circle, Agricultural Unions consisting of co-operative societies (and not of individual members) have been formed, while in Berar, societies independent of previously existing credit organizations have been organized in the form of Agricultural Unions. These Unions maintain a central seed farm for the production of cotton seed and provide ginning machinery for ginning the seed of *roseum* cotton from a number of branch farms run by the members. The capital is used in running the central farm and the supply of the necessary gins; and the seed which they use on the central farm is obtained annually from the Agricultural Department. The financial result has hitherto been satisfactory and the extension of such unions will bring about an ultimate transfer from the Agricultural Department of the work of spreading the improved forms of cotton seed suitable to the district.

As regards cattle-breeding societies in this province the Newagaon Co-operative Society, though not truly co-operative, has succeeded in spreading an interest in cattle-breeding in many parts of the district. A small Cattle-breeding Society at Khandwa which has leased the fuel and fodder reserves of 288 acres from Government and which is working on much more co-operative lines promises to do good work.

In the cotton tract of Burma many co-operative organizations are now appearing for the purpose of the formation of co-operative ginneries. These will remove one of the difficulties confronting the progressive cultivators in securing good seed for which they have to pay high prices and make a special journey of several miles to the mills at Myingyan.

In Assam, seed distribution was made in the year under report through certain co-operative credit societies and the Registrar has allowed certain societies in the neighbourhood of Palasbari to amend their by-laws so that they may add co-operative methods of production and sale to their existing activities.

As regards co-operative dairy societies the experiment at Nagpur organized by the Central Provinces Agricultural Department is an interesting one. Full particulars are given in the July (1914) number of the *Agricultural Journal of India.* Another interesting concern, the Benares Co-operative Dairy, has been described in Dr. Mann's paper on the supply of milk to Indian cities, in the April (1914) number of the same Journal. There appears to be little doubt that the successful improvement of the Indian Dairy Industry and the production of a better cow will depend upon the co-operative system, but the co-operative system here must be run with equal reference to improving the breed of cow as well as cheapening the supply of produce. Any attempt at Suburban Dairy Farming which is so tempting from a profit making and produce cheapening point of view is only robbing Peter to pay Paul.

The question of co-operative cattle insurance also offers wide possibilities of achievement in future. Quite a large number of co-operative cattle insurance societies are reported to be working successfully in Burma. This question was considered at the sixth Conference of the Registrars of Co-operative Societies who came to the conclusion that cattle insurance should not be undertaken unless adequate means existed of applying prophylactic measures. The Board of Agriculture which met at Coimbatore in December 1913, also considered the question of cattle insurance and passed a resolution expressing the hope that the Registrars of Co-operative Societies, would raise no objection to the establishment of co-operative cattle insurance societies where the Veterinary Department can guarantee facilities for inoculation on the outbreak of disease. The report of the Committee which sat to consider this question and the discussion at the full meeting of the Board is instruc-

tive and will be found in the published Proceedings of the Board.

A paper on co-operative cattle insurance read by Major Walker at the Co-operative Conference held at Poona in August 1914, detailing the conditions necessary for the successful working of such societies and giving other useful particulars will be found in the *Agricultural Journal of India* for January, 1915.

PART V.

Publications and Expenditure.

(1) **Publications.**—During the year under report the Imperial Department of Agriculture published 16 Memoirs and 7 Bulletins. The Memoirs included a number of papers in the Botanical, Chemical and Veterinary Series. A monograph on the Imperial Bacteriological Laboratory, Muktesar, its work and products was issued during the year with a view not only to popularize its products but also to make the institution known to the scientific public and to attract young investigators to work at the Laboratory. Its Hindi and Urdu versions were also issued and widely distributed in India. There is an increasing demand for Bulletins from the Indian public. Bulletins Nos. 28 and 29 on Lac and Eri Silk Culture have been reprinted. A Hindi translation of the Bulletin on Lac Cultivation has been issued and steps have also been taken to publish the Bengali version of the Bulletin on Mulberry Silk Culture. A vernacular translation of Dr. Butler's article on the "*Ufra*" disease of rice and of Mr. Howard's paper on the "Yield and Improvement in the Quality of Wheat in India" has been published by the Department of Agriculture, Bengal. It may be mentioned that Hindi and Urdu versions of this latter paper and another on the Seed Supply of the New Pusa Wheats were published by the Imperial Department of Agriculture and distributed widely.

The quarterly *Agricultural Journal of India* continued to be issued during the year.

The grant for publications as at present sanctioned is Rs. 29,000.

The Department of Agriculture, Bombay, published during the year, 7 Bulletins and 4 Leaflets, the latter with their vernacular versions. The Bulletin on "Sugarcane—Its Cultivation and *Gul* Manufacture" is worthy of special mention as it records the progress made by the Department in effecting improvements during the last ten years. The Department

gives considerable assistance and support to the three agricultural journals issued in Marathi, Kanarese and Gujarati. The Agricultural College, Poona, also publishes a magazine in English containing useful agricultural matter.

The Department of Agriculture, Madras, distributed over 72,000 copies of the Agricultural Calendar published in five languages. Among other publications by this Department there is a note on "Insects attacking the paddy plant in Southern India" by Mr. T. Bainbrigge Fletcher and one on a Soil Survey of the Tanjore delta by Mr. Harrison.

The Department of Agriculture, Bengal, has taken over the publication in Bengali of a Year Book of the Department which used to be issued by the Agricultural Department of the late Government of Eastern Bengal and Assam.

In Bihar an important Crop Pest Hand Book compiled by Messrs. Dutt and Basu and edited by Mr. E. J. Woodhouse, was published during the year. This Department also issues a half-yearly Agricultural Journal.

Among the publications issued by the United Provinces Department may be noted two bulletins on Rinderpest and Glanders and one on the "Improvement of the Milk Supply in the Towns of the Province." Mr. Clarke's Bulletin on "Cane crushing in the United Provinces" has been published as *Pusa Bulletin No. 42.* The vernacular journal *Mufid-ul-Mazarain* continued to be issued during the year and is steadily increasing in circulation.

Among the publications issued by the Punjab Department of Agriculture are included the Year Book, 1914, and "Sugar in Punjab—Progress Report for 1913."

In the Central Provinces the *Agricultural and Co-operative Gazette* continued to be issued monthly in three languages, English, Marathi and Hindi, and contained notes on Co-operation and other matters of interest.

The Department of Agriculture, Burma, published in vernacular an Agricultural Calendar for 1914-15. Among other publications the Bulletin on the chemical composition of paddy mill products by Mr. F. J. Warth and his Assistant deserves mention.

A complete list of the publications issued by the Imperial and Provincial Departments of Agriculture during the year is given as an appendix to this report.

(2) **Expenditure.**—The total expenditure incurred by the Imperial Department of Agriculture during the financial year 1913-14 was Rs. 4,96,534 as under :—

	Rs.
Office of the Agricultural Adviser to the Government of India and Director of the Institute	2,14,158
Imperial Cotton Specialist	24,063
Chemical Section	38,455
Mycological Section	37,388
Entomological Section	33,942
Pathological Entomological Section	26,749
Botanical Section	27,854
Bacteriological Section	29,171
Agricultural Section	64,754
TOTAL	4,96,534

The above amount of Rs. 4,96,534, included expenditure under the special grant of Rs. 10,000 placed at the disposal of the Agricultural Adviser for special agricultural experiments. Out of this grant a portion was spent (*i*) in purchasing merino rams for the Central Provinces Department of Agriculture, (*ii*) in helping the fruit industry at Quetta, and (*iii*) in carrying out poultry experiments at Pusa.

The Budget of the Agricultural Adviser for the year under report includes (1) a portion of the grant of Rs. 1,10,000 referred to in the previous year's report for meeting the expenditure in connection with the engagement of Mr. W. Hulme as Sugar Engineer in the United Provinces for the development of the Indian Sugar Industry, (2) a grant of Rs. 15,000 for payment to the Indian Tea Association as a grant-in-aid, and (3) a lump sum of Rs. 60,000 allotted by the Government of India during the year ending 31st March 1914 for the improvements connected with the Pusa Institute. Out of this sum of Rs. 60,000, Rs. 14,254 were transferred to the Public Works Department Budget for meeting the cost of extension of the Pusa Library, Rs. 25,000 paid towards the purchase of steam tackle for the Pusa Farm and the balance spent on testing the milling

and baking qualities of wheat, the bacteriological investigation of rice, the demonstration of improved methods of refining saltpetre, experiments with cotton and plant breeding by the Imperial Cotton Specialist, construction of a pot-culture house for the Imperial Mycologist, an additional laboratory for the Imperial Pathological Entomologist, and the improvement of the drainage of the low-lying portions of the Pusa Estate.

The expenditure in the working of the Imperial Bacteriological Laboratory at Muktesar and at Bareilly during the year 1913-14 was as under :—

	Rs.
Salaries and travelling allowance of officers and establishment	83,349
Feed and keep of animals	67,998
Purchase of animals	17,280
Cost of chemicals and apparatus	7,476
Other miscellaneous expenditure	27,102
TOTAL	2,03,205

The total expenditure incurred by the Provincial Departments of Agriculture during the year under report was Rs. 46,34,118. The details are as under :—

	Rs.
Bengal	4,57,292
Bihar and Orissa	3,09,846
United Provinces of Agra and Oudh	6,67,907
Punjab	7,39,223*
Bombay	7,78,861†
Madras	5,54,749‡
Central Provinces	6,70,870§
Burma	1,96,547‖
Assam	1,84,744
North-West Frontier Province	74,079
TOTAL	46,34,118

* This includes Rs. 4,44,153 spent on buildings (original works).

† This includes Rs. 53,630 of capital expenditure on Agricultural College and School buildings and Rs. 2,749 expended for the Contingencies of the Loni School from the District Local Board money.

‡ This includes Rs. 34,930 of capital expenditure on purchase of land for Sirvel and Anakapalle Farms and extension of Palur Farm; also Rs. 1,560 debitable to Imperial Funds.

§ Includes expenditure on Veterinary Department, Nagpur Museum, and Government Gardens amounting to Rs. 3,05,681.

‖ Includes Rs. 4,762 and Rs. 18,850 of expenditure on experimental and botanical and other gardens.

¶ This includes Rs. 38,694 for cost of land purchased for the extension of Agricultural Farm, Peshawar.

APPENDIX.

List of Agricultural Publications in India during 1913-14.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE.		
1	The *Agricultural Journal of India*, Vol. VIII, Parts III and IV, and Vol. IX, Parts I and II. Price per Part, Rs. 2; annual subscription, Rs. 6.	Issued from the Agricultural Research Institute, and College, Pusa, Bihar.	Messrs. Thacker, Spink & Co., Calcutta.
2	Proceedings of the Board of Agriculture in India, held at Coimbatore on the 8th December, 1913, and following days (with Appendices). Price Re. 1-2 or 1*s.* 9*d.*	Issued from the Agricultural Research Institute, Pusa, Bihar.	Government Printing, India, Calcutta.
3	Fourth Report on the Introduction of Improvements into Indian Agriculture by the work of the Agricultural Department. Price As. 2 or 3d.	Ditto .	Ditto.
4	Report on the Flax Experiments conducted at Dooriah during the year 1912-13. Bulletin No. 35 of the Agricultural Research Institute, Pusa. Price As. 3 or 5*d.*	E. M. Vandekerkhove, Flax Expert to the Bihar Planters' Association.	Ditto.
5	The Improvement of Indigo in Bihar (with notes on Drainage and on Green Manuring).	A. Howard, M.A., A.R.C.S., F.L.S., and G. L. C. Howard, M.A.	Baptist Mission Press, Calcutta.
6	Report on the Progress of Agriculture in India for 1912-13. Price As. 8 or 9*d.*	Agricultural Adviser to the Government of India, Pusa.	Government Printing India, Calcutta.
7	Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for 1912-13. Price As. 7 or 8*d.*	Director, Agricultural Research Institute Pusa, Bihar.	Ditto.
8	Area and Yield of Certain Principal Crops in India, from 1898-99 to 1912-13. Price As. 4 or 6*d.*	Issued by the Commercial Intelligence Department, India.	Ditto.
9	Agricultural Statistics of India, for the years 1907-08 to 1911-12, Vol. I. Price Rs. 2-8 or 3*s.* 9*d.*	Director-General of Commercial Intelligence.	Ditto.
10	Agricultural Statistics of India, for the years 1907-08 to 1911-12, Vol. II. Price Re. 1 or 1*s.* 6*d.*	Ditto .	Ditto.
11	Annual Report of the Board of Scientific Advice for the year 1912-13. Price Re. 1.	Issued by the Board of Scientific Advice for India.	Ditto.
12	Agricultural Sayings of Bengal with Analogous Sayings in Bihar and Orissa. Bulletin No. 1 of 1913. Price As. 6.	P. L. Banerjee . .	Bengal Secretariat Book Depôt, Calcutta.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
13	Season and Crop Report of Bengal for 1913-14. Price As. 15.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
14	Report of the Agricultural Department, Bengal, for the year ending 30th June, 1913. Price As. 7 or 8*d.*	Ditto.	Ditto.
15	Annual Report of the Chinsura Agricultural Station for 1912-13. Price anna 1-9 or 2*d.*	Ditto.	Ditto.
16	Annual Report of the Rajshahi Agricultural Station for 1912-13. Price 1 anna or 1*d.*	Ditto	Ditto.
17	Annual Report of the Burirhat Agricultural Station for 1912-13. Price 1 anna or 1*d.*	Ditto	Ditto.
18	Annual Report of the Dacca Agricultural Station for 1912-13. Price As. 2-6 or 3*d.*	Ditto	Ditto.
19	Annual Report of the Rangpur Farm for 1912-13. Price anna 1-9 or 2*d.*	Ditto	Bengal Secretariat Press, Calcutta.
20	Annual Report of the Demonstration Farm, St. Andrew's Colonial Homes, Kalimpong, for 1912-13. Price As. 2-6 or 3*d.*	Ditto	Secretariat Book Depôt, Calcutta.
21	*Krishi Samachar* or the Year Book of the Department of Agriculture, Bengal, for the year 1320.	Ditto	Ditto.
22	Season and Crop Report of Bihar and Orissa for 1913-14.	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
23	Report of the Agricultural Department, Bihar and Orissa, for the year ending 30th June 1913. Price As. 8 or 9*d.*	Ditto	Ditto.
24	Report on the Agricultural Stations in Bihar and Orissa, for 1912-13. Price Re. 1 or 1*s.* 6*d.*	Ditto	Ditto.
25	*The Agricultural Journal* (half yearly), Vol. I, No. 2, October, 1913, and Vol. II, No. 1, April, 1914. Annual subscription Re. 1.	Ditto	Ditto.
26	Agricultural Statistics of Bihar and Orissa, for 1912-13.	Ditto	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
27	Monsoon Rainfall Tables of Bihar and Orissa for 1913.	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press. Patna.
28	Seed Store at Sabour, Leaflet No. 1 of 1914.	Ditto .	Ditto.
29	Names of the field and market garden crops and of the principal fruit and timber trees of the United Provinces. Bulletin No. 30 (revised edition of Bull. No. 4 of the Department of Agriculture, United Provinces). Price As. 7.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
30	Report of the Department of Agriculture, United Provinces, for the year ending 30th June, 1913. Price As. 8 or 9*d.*	Ditto .	Ditto.
31	Report on the Cawnpore Agricultural Station for the year ending 30th June, 1913. Price Re. 1 or 1*s.* 6*d.*	Ditto .	Ditto.
32	Report on the Orai (Jalaun) Agricultural Station for the year ending 30th June, 1913. Price As. 8 or 9*d.*	Ditto .	Ditto.
33	Report on the Aligarh Agricultural Station for the year ending 30th June, 1913. Price As. 8 or 9*d.*	Ditto .	Ditto.
34	Report on the Partabgarh Agricultural Station for the year ending 30th June, 1913. Price As. 8 or 9*d.*	Ditto .	Ditto.
35	Report on the Benares Agricultural Station for the year ending 30th June, 1913. Price As. 8 or 9*d.*	Ditto .	Ditto.
36	The Improvement of the Milk Supply in the towns of the United Provinces. Bulletin No. 29. Price 6 pies.	The Hon. Mr. H. R. C. Hailey, I.C.S., Director of Land Records and Agriculture, United Provinces.	Ditto.
37	Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1913.	Issued by the Department of Agriculture, Punjab.	Government Press, Lahore.
38	Year Book of the Punjab Agricultural Department, 1914. Price Re. 1-4 or 1*s.* 10*d.*	Ditto .	Ditto.
39	Season and Crop Report of the Punjab for 1912-13.	Ditto .	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
40	Annual Report of the Agri-horticultural Gardens, Lahore, for 1912-13.	Issued by the Department of Agriculture, Punjab.	Government Press, Lahore.
41	List of Ploughs and other Agricultural Implements recommended by the Punjab Agricultural Department (Illustrated), 1914.	Ditto	Ditto.
42	Annual Report of the Surat Agricultural Station for 1912-13. Price Re. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
43	Annual Report of the Dhulia Agricultural Station for 1912-13. Price Re. 1 or 1*s.* 6*d.*	Ditto	Ditto.
44	Annual Report of the Nadiad Agricultural Station for 1912-13. Price As. 14 or 1*s.* 4*d.*	Ditto	Ditto.
45	Annual Report of the Dohad Agricultural Station for 1912-13. Price As. 12 or 1*s.* 2*d.*	Ditto	Ditto.
46	Annual Report of the Dharwar Agricultural Station for 1912-13. Price Re. 1 or 1*s.* 6*d.*	Ditto	Ditto.
47	Annual Report of the Gokak Agricultural Station for 1912-13. Price As. 14 or 1*s.* 4*d.*	Ditto	Ditto.
48	Annual Report of the Gadag Agricultural Station for 1912-13. Price As. 14 or 1*s.* 4*d.*	Ditto	Ditto.
49	Annual Report of the Mirpurkhas Agricultural Station for 1912-13. Price As. 7 or 8*d.*	Ditto	Ditto.
50	Annual Report of the Sukkur Agricultural Station for 1912-13. Price As. 6 or 7*d.*	Ditto	Ditto.
51	Annual Report of the Alibag Agricultural Station for 1912-13. Price As. 10 or 11*d.*	Ditto	Ditto.
52	Annual Report of the Poona Agricultural College Station for 1912-13. Price As. 8 or 9*d.*	Ditto	Ditto.
53	Proceedings of the Agricultural Conference held at Poona in September, 1913. Price Re. 1-4 or 1*s.* 10*d.*	W. W. Smart, I.C.S., Officiating Director of Agriculture, Bombay.	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
54	Annual Report of the Department of Agriculture, Bombay Presidency, for 1912-13. Price As. 10 or 11*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
55	Season and Crop Report of the Bombay Presidency for 1912-13. Price As. 5 or 6*d.*	Ditto .	Ditto.
56	Annual Report of the Manjri Farm for 1912-13. Price As. 4 or 5*d.*	Ditto .	Ditto.
57	Annual Report of the Kirkee Civil Dairy for 1912-13. Price As. 3 or 4*d.*	Ditto .	Ditto.
58	Annual Report of the Ganeshkhind Botanical Garden for 1912-13. Price As. 4 or 5*d.*	Ditto .	Ditto.
59	Present State of Dairy Industry in Bombay. Bulletin No. 56 of the Department of Agriculture, Bombay. Price As. 3 or 3*d.*	J. B. Knight, M.Sc., B.Sc., Professor of Agriculture, Agricultural College, Poona, and E. W. Horn, Manager, Government Civil Dairy.	Ditto.
60	Improvement of the Indigenous plough of Western India. Bulletin No. 57 of the Department of Agriculture, Bombay. Price As. 12 or 1*s.* 2*d.*	S. S. Godbole, L.C.E., Assistant Professor of Physics, Agricultural College, Poona.	Ditto.
61	Prickly-pear Experiments. Bulletin No. 58 of the Department of Agriculture, Bombay. Price As. 14 or 1*s.* 4*d.*	E. W. Horn, Manager, Government Civil Dairy.	Ditto.
62	Common Salt and its use as Manure in the Konkan Division. Bulletin No. 59 of the Department of Agriculture, Bombay. Price As. 3 or 3*d.*	V. H. Gonehalli, M.A., Extra Deputy Director of Agriculture, Konkan Division.	Ditto.
63	Sugarcane—Its Cultivation and Gul Manufacture. Bulletin No. 61 of the Department of Agriculture, Bombay. Price As. 5 or 6*d.*	J. B. Knight, M.Sc., Professor of Agriculture, Agricultural College, Poona.	Ditto.
64	The value of Castration of Deccan Bullocks. Bulletin No. 62 of the Department of Agriculture, Bombay. Price As. 3 or 3*d.*	Ditto .	Ditto.
65	Substitutes for Rab, Bulletin No. 63 of the Department of Agriculture, Bombay. Price As. 3 or 3*d.*	Ditto .	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
66	Cultivation of Potatoes in Bombay Presidency. Leaflet No. 7 of 1913.	Issued by the Department of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
67	Hints on Fig Cultivation. Leaflet No. 1 of 1914.	Ditto .	Ditto.
68	Bullock Feeding. Leaflet No. 2 of 1914	Ditto .	Ditto.
69	Manure for Potatoes. Leaflet No. 3 of 1914.	Ditto .	Ditto.
70	Single Seedling Transplanting of Paddy. Leaflet No. 9 of 1913.	M. R. Ry. K. P. Karuthirama Gounden.	Government Press, Madras.
71	Ill-effects of Communal Grazing. Leaflet No. 11 of 1913.	D. T. Chadwick, I.C.S., Director of Agriculture, and F. Ware, Superintendent, Civil Veterinary Department, Madras.	Ditto.
72	The Advantages of Co-operative Sale of Cotton.	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Division, Madras.	Ditto.
73	The Fodder Question in Coimbatore .	R. Cecil Wood, M.A., Principal, Agricultural College, Coimbatore.	Ditto.
74	Scientific Report of the Nandyal Agricultural Station for 1912-13. Price 1 anna or 1*d.*	Issued by the Department of Agriculture, Madras.	Ditto.
75	Scientific Report of the Hagari Agricultural Station for 1912-13. Price 1 anna or 1*d.*	Ditto .	Ditto.
76	Scientific Report of the Palur Agricultural Station for 1912-13. Price 1 anna or 1*d.*	Ditto .	Ditto.
77	Scientific Report of the Koilpatti Agricultural Station for 1912-13. Price 1½ anna or 3*d.*	Ditto .	Ditto.
78	Scientific Report of the Taliparamba Agricultural Station for 1912-13. Price 1½ anna or 3*d.*	Ditto .	Ditto.
79	Scientific Report of the Coimbatore Agricultural Station for 1912-13. Price As. 2 or 2*d.*	Ditto .	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
80	Annual Report of the Agricultural Department, Madras, for 1912-13. Price As. 3 or 3*d.*	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
81	Report on the working of the Department of Agriculture, Central Provinces and Berar, for 1912-13. Price Re. 1.	Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
82	Report on the Management of the Provincial and District Gardens, Central Provinces and Berar, for 1912-13. Price As. 4.	Ditto .	Ditto.
83	*The Agricultural and Co-operative Gazette*, July 1913 to June 1914. Price per copy As. 2. Issued monthly.	Ditto .	Desh Sevak Press, Nagpur.
84	Season and Crop Report of the Central Provinces and Berar for the year 1912-13. Price As. 8 or 9*d.*	Ditto	Government Press, Central Provinces, Nagpur.
85	Report on the Agricultural Stations in the Central Provinces and Berar for the year 1912-13. Price Re. 1.	Ditto	Ditto.
86	Report of the Agricultural Department, Assam, for the year ending 30th June, 1913.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
87	Annual Report on the Agricultural Experiments and Demonstrations in Assam for the year ending 30th June, 1913. Price As. 12 or 1*s.*	Ditto .	Ditto.
88	Annual Report on the Fruit Experiment Station, Shillong, for the year ending 30th June, 1913.	Ditto .	Ditto.
89	Annual Report of the Upper Shillong Agricultural Experiment Station for the year ending 30th June, 1913.	Ditto .	Ditto.
90	Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June, 1913.	Ditto .	Ditto.
91	Report on the Season and Crops of Assam for 1913-14. Price As. 8 or 9*d.*	Ditto .	Ditto.
92	Season and Crop Report of Burma for 1913-14. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*contd.*		
93	Report of the Mandalay Agricultural Station for the year 1912-13.	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
94	Report of the Hmawbi Agricultural Station for the year 1912-13.	Ditto .	Ditto.
95	Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June, 1913. Price As. 4 or 4*d.*	Ditto .	Ditto.
96	Chaff cutters and Bullock Gears, Cultivators' leaflet No. 43.	Ditto .	Ditto.
97	Annual Report of the Peshawar Agricultural Station for the year ending the 30th June, 1913.	Issued by the Department of Agriculture, North-West Frontier Province.	Messrs. Thacker, Spink & Co., Calcutta.
98	A trial of orange stocks at Peshawar (reprinted from the *Agricultural Journal of India* for January, 1914).	W. Robertson Brown, Agricultural Officer, North-West Frontier Province.	Ditto.
99	Rye-grass and clover in India (reprinted from the *Agricultural Journal of India* for January, 1914).	Ditto .	Ditto.
100	Summary of Remarks on the Kharif Crops of the North-West Frontier Province, for 1913.	Department of Agriculture, North-West Frontier Province.	North-West Frontier Province Government Press, Peshawar.
101	Report on the Season and Crops of the North-West Frontier Province for the year 1912-13.	Ditto .	Ditto.
102	*The Quarterly Journal of the Madras Agricultural Students' Union.* Annual subscription Re. 1.	Madras Agricultural Students' Union.	Guardian Press, Mount Road, Madras.
103	*Indian Tea Association Scientific Department, Quarterly Journal.* Parts III and IV, 1913; Parts I and II, 1914. Price As. 6 per copy.	Indian Tea Association, Scientific Department.	Catholic Orphan Press, Calcutta.
104	Annual Report of the Department of Agriculture, Mysore, for 1912-13.	Department of Agriculture, Mysore.	Mysore Government Press, Bangalore.
105	Report on the working of the Gardens and Parks in Mysore during 1912-13.	Issued by the Department of Agriculture, Mysore.	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	GENERAL AGRICULTURE—*concld.*		
106	Report on the Operations of the Department of Agriculture, Travancore, for 1912-13.	Issued by the Department of Agriculture, Travancore.	Travancore Government Press, Trivandrum.
107	The *Poona Agricultural College Magazine*, Vol. V, Nos. 1-4 (quarterly). Annual subscription Rs. 2, single copy As. 9.	College Magazine Committee, Poona.	Arya Bhushan Press, Poona.
108	Tube Wells—Boring, Sinking, and Working (Second Edition). Price Rs. 5.	T. A. Miller Brownlie, C.E.	Messrs. Thacker, Spink & Co., Calcutta.
109	The *Indian Agricultural World* (monthly). Subscription Rs. 10.	Messrs. P. A. V. Iyer & Co., Triplicane, Madras, S.E.	Commercial Press, Madras.
110	*Indian Poultry Gazette* (monthly). Subscription Rs. 3 per annum.	Issued by the Indian Poultry Club, Lucknow.	Mafussilite Electrical Printing Works, Mussoorie.
	AGRICULTURAL CHEMISTRY.		
111	The Gases of Swamp Rice Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 3. Price Re. 1-8.	W. H. Harrison, M.Sc., Government Agricultural Chemist, Madras; and P. A. Subramania Aiyar, B.A., Assistant to the Government Agricultural Chemist.	Messrs. Thacker, Spink & Co., Calcutta.
112	Experimental Error in Sampling Sugarcane. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 4. Price Re. 1.	J. W. Leather, Ph.D., F.I.C., Imperial Agricultural Chemist.	Ditto.
113	The Fractional Liquefaction of Rice Starch. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 5. Price Re. 1 or 1*s.* 6*d.*	F. J. Warth, M.Sc., Agricultural Chemist, Burma; and D. B. Darabsett, B.Sc., Senior Assistant to the Agricultural Chemist, Burma.	Ditto.
114	The Yield and Composition of the Milk of the Montgomery Herd at Pusa and Errors in Milk Tests. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 6. Price Re. 1 or 1*s.* 6*d.*	J. W. Leather, Ph.D., F.I.C., Imperial Agricultural Chemist; and A. C. Dobbs, Assistant to the Agricultural Adviser to the Government of India.	Ditto.
115	Notes on Experiments with Sugarcane at Sabour. Bulletin No. 37 of the Agricultural Research Institute, Pusa. Price As. 2 or 3*d.*	C. Somers Taylor, B.A., Agricultural Chemist, Bihar and Orissa.	Government Printing, India, Calcutta.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	AGRICULTURAL CHEMISTRY—*contd.*		
116	Disintegration of Rice Grains by means of Alkali. Bulletin No. 38 of the Agricultural Research Institute, Pusa. Price As. 6 or 7*d.*	F. J. Warth, M.Sc., Agricultural Chemist, Burma; and D. B. Darabsett, B.Sc., Senior Assistant to the Agricultural Chemist, Burma.	Government Printing, India, Calcutta.
117	Progress Report on Sugar in the Punjab for 1913.	J. H. Barnes, B.Sc., F.I.C., Agricultural Chemist, Punjab.	Government Printing, Punjab, Lahore.
118	The Chemical Composition of Paddy Mill Products. Bulletin No. 10 of the Department of Agriculture, Burma. Price As. 2 or 2*d.*	F. J. Warth, M.Sc., Agricultural Chemist, Burma; and D. B. Darabsett, B.Sc., First Assistant to the Agricultural Chemist.	Government Printing, Burma, Rangoon.
119	Report upon Soil Survey of the Tanjore Delta. Bulletin No. 68 of the Department of Agriculture, Madras.	W. H. Harrison, M.Sc., Agricultural Chemist, Madras.	Government Press, Madras.
	BOTANY.		
120	Studies in Indian Tobaccos, No. 3. The Inheritance of Characters in *Nicotiana tabacum*, L. Memoirs of the Department of Agriculture in India. Botanical Series, Vol. VI, No. 3. Price Rs. 3.	Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.
121	Studies in Indian Cotton, Part I—The Vegetative Characters. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VI, No. 4. Price Rs. 3-8.	H. Martin Leake, M.A., F.L.S., Economic Botanist to Government, United Provinces; and Ram Prassad, Assistant to the Economic Botanist.	Ditto.
122	Preliminary Note on the Classification of Rice in the Central Provinces. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VI, No. 7. Price Re. 1-8.	R. J. D. Graham, M.A., B.Sc., Economic Botanist, Central Provinces.	Ditto.
123	The Seed Supply of the New Pusa Wheats (English, Hindi, and Urdu).	A. Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist; and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	The Baptist Mission Press, Calcutta.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	BOTANY—*contd.*		
124	Date cultivation in the Punjab (revised note). Price Re. 1-2.	D. Milne, B.Sc., Economic Botanist, Punjab.	Punjab Government Press, Lahore.
125	Cultivation of the Coconut Palm in Burma. Bulletin No. 11 .Price As. 2 or 2*d.*	A. M. Sawyer, Assistant Botanist, Mandalay.	Government Printing, Burma, Rangoon.
126	Bengali translation of Mr. Howard's paper on the Yield and Quality of Wheat in India.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
	MYCOLOGY.		
127	The Red Rot of Sugarcane. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VI, No. 5. Price Re. 1.	E. J. Butler, M.B., F.L.S., Imperial Mycologist; and A. Hafiz Khan, Assistant to the Imperial Mycologist.	Messrs. Thacker, Spink & Co., Calcutta.
128	Some New Sugarcane Diseases. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VI, No. 6. Price Rs. 2.	Ditto .	Ditto.
129	Potato Disease, Bordeaux Mixture—Its preventive measures. Leaflet No. 2 of 1913.	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
130	The Mahali Disease of Areca nuts. Leaflet No. 7 of 1913 of the Department of Agriculture, Madras.	F. J. F. Shaw, B.Sc., A.R.C.S., F.L.S., Acting Government Mycologist.	Government Press, Madras.
131	The Bud-rot of Coconuts in the Malabar District. Leaflet No. 10 of 1914 of the Department of Agriculture, Madras.	William McRae, M.A., B.Sc., and F. J. F. Shaw, B.Sc., A.R.C.S., F.L.S., Government Mycologists.	Ditto.
132	Bengali translation of Dr. E. J. Butler's paper on the Ufra Disease of Rice.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat, Press, Calcutta.
133	Cultivator's Leaflet No. 44. The Symptoms of "Ufra" Disease of Rice.	A. McKerral, M.A., B.Sc., Deputy Director of Agriculture, Southern Circle, Burma.	Government Printing, Burma, Rangoon.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	ENTOMOLOGY.		
134	The "Psylla Disease" of Indigo. Memoirs of the Department of Agriculture in India, Entomological Series, Vol. IV, No. 6. Price Re. 1-8.	A. J. Grove, M.Sc., offg. Imperial Entomologist; and C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Messrs. Thacker, Spink & Co., Calcutta.
135	Life Histories of Indian Insects—V (*Lepidoptera*). Memoirs of the Department of Agriculture in India. Entomological Series, Vol. V, No. 1. Price Rs. 2-8.	C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Ditto.
136	Instructions for rearing Mulberry Silkworms. Bulletin No. 39 of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d*.	M. N. De, Sericultural Assistant to the Imperial Entomologist.	Government Printing, India, Calcutta.
137	The Cultivation of Lac in the Plains of India. Bulletin No. 28 (revised edition) of the Agricultural Research Institute, Pusa. Price As. 8.	C. S. Misra, B.A., First Assistant to the Imperial Entomologist.	Ditto.
138	Hindi translation of Pusa Bulletin No. 28 on the Cultivation of Lac in the Plains of India. Price As. 8 or 9*d*.	Ditto .	Ditto.
139	Directions for the Cultivation of Eri Silk (second edition). Bulletin No. 29. Price As. 3.	Issued by the Agricultural Research Institute, Pusa.	Ditto.
140	Note on the Green Scale of Coffee (*Lecanium viride*).	T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Imperial Entomologist.	Government Press, Mercara, Coorg.
141	Large Brown Cockroach, Leaflet No. 1 of 1914 (in English and Bengali).	P. C. Sen, Entomological Collector, Bengal.	Obtainable from the Department of Agriculture, Bengal.
142	*Dhanerpoka* or Insect Enemies of Rice (in Bengali). Price As. 8.	Ditto .	Ditto.
143	Culture of certain voracious Fish in Tanks. Fishery Bulletin No. 3 of 1913.	T. Southwell, Deputy Director of Fisheries, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
144	Some Remarks on Fishery Questions in Bengal. Fishery Bulletin No. 4 of 1914. Price As. 5.	Ditto .	Ditto.
145	Insect-pests and General Measures for prevention and remedy. Leaflet No. 3 of 1913.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	ENTOMOLOGY—*contd.*		
146	Preliminary Report on Cotton Boll Worm in the Punjab.	L. Madan Mohan Lal, Assistant Professor of Entomology, Agricultural College, Lyallpur.	Punjab Government Press, Lahore.
147	Note on Insect-pests in Rice Plants in Southern India, Bulletin No. 67. Price 1 anna 6 pies.	T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Government Entomologist, Madras.	Government Press, Madras.
148	Practical Instructions for the Kollegal Mulberry Silkworm rearers.	Ditto .	Ditto.
149	Some General Methods of Controlling attacks by Insect Pests—Agricultural Methods.	Ditto .	Ditto.
150	Some General Methods of Controlling attacks by Insect Pests—Mechanical Methods.	Ditto .	Ditto.
151	Crop Pest Handbook for Bihar and Orissa (including Western Bengal). Price Rs. 4.	Issued by the Department of Agriculture, Bihar and Orissa.	Messrs. Thacker, Spink & Co., Calcutta.
	AGRICULTURAL BACTERIOLOGY.		
152	Green Manuring Experiment, 1912-13. Bulletin No. 40, of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d*.	C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist, and S. Milligan, M.A., B.SC., Imperial Agriculturist.	Government Printing, India, Calcutta.
	VETERINARY.		
153	On the Immune Bodies occurring in Anti-rinderpest serum, and on the variations occurring in the Serum Proteins of animals during Rinderpest, and during Immunisation and Hyper-immunisation. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. I, No. 4. Price Rs. 2.	Percival Hartley, D.SC., Imperial Bacteriological Laboratory, Muktesar, United Provinces.	Messrs. Thacker, Spink & Co., Calcutta.
154	Some cases of Surra treated in the Field and in the Laboratory during the autumn of 1911. Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. II, No. 1. Price Re. 1.	Major J. D. E. Holmes, C.I.E., M.A., D.SC., M.R.C.V.S., Imperial Bacteriologist, Muktesar.	Ditto.

List of Agricultural Publications in India during 1913-14—contd.

No.	Title.	Author.	Where published.
	VETERINARY—*contd.*		
155	Rinderpest. Further investigations on questions connected with the economical production of Anti-serum. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. II, No. 2. Price Re. 1.	Major J. D. E. Holmes, C.I.E., M.A., D.SC., M.R.C.V.S., Imperial Bacteriologist, Muktesar.	Messrs. Thacker, Spink & Co., Calcutta.
156	The Curative Treatment of Hæmorrhagic Septicæmia in Cattle by the administration of Iodine and other Notes on Chemiotherapy in Rinderpest and Hæmorrhagic Septicæmia. Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. II, No. 3. Price Re. 1 or 1*s.* 6*d.*	Ditto .	Ditto.
157	The Vitality of the Hæmorrhagic Septicæmia Organism outside the Body. Memoirs of the Department of Agriculture in India, Veterinary Series, Vol. II, No. 4. Price Re. 1 or 1*s.* 6*d.*	Ditto .	Ditto.
158	Note on the McFadyean staining reaction for Anthrax Bacilli. Bulletin No. 36 of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d.*	Ditto .	Government Printing, India, Calcutta.
159	Annual Report of the Imperial Bacteriologist for 1912-13. Price As. 3 or 4*d.*	Issued by the Agricultural Adviser to the Government of India.	Ditto.
160	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1913-14.	Issued by the Veterinary Department, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
161	Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1912-13.	Issued by the Department of Agriculture, Punjab.	Government Press, Lahore.
162	Annual Report of the Camel Specialist for 1912-13.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
163	Equine Biliary Fever . . .	J. F. Valladares, Deputy Superintendent, Civil Veterinary Department, Central Provinces.	Printed in *Parasitology*, May 1914, published by Messrs. Macmillan & Co., Ltd., Bombay and Calcutta.
164	Report of the Civil Veterinary Department, Assam, for 1913-14. Price As. 8 or 9*d.*	Issued by the Civil Veterinary Department, Assam.	Assam Secretariat Printing Office, Shillong.

List of Agricultural Publications in India during 1913-14—concld.

No.	Title.	Author.	Where published.
	VETERINARY—*concld.*		
165	Report on the Civil Veterinary Department, United Provinces, for the year ending 31st March 1913.	Issued by the Department of Land Records and Agriculture, United Provinces.	Government Press, Allahabad.
166	Note on Rinderpest. Bulletin No. 28 of the Department of Agriculture, United Provinces. Price As. 3 or 4*d*.	E. W. Oliver, M.R.C.V.S., F.Z.S., Superintendent, Civil Veterinary Department, United Provinces.	Ditto.
167	Annual Report on the Civil Veterinary Department, United Provinces, for the year ending 30th March 1914. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
168	Notes on Glanders. Bulletin No. 31 of the Department of Land Records and Agriculture, United Provinces. Price As. 2.	E. W. Oliver, M.R.C.V.S., F.Z.S., Superintendent, Civil Veterinary Department.	Ditto.
169	Administration Report of the Civil Veterinary Department, Madras, for 1912-13. Price Re. 1-2 or 1*s*. 9*d*.	Civil Veterinary Department, Madras.	Government Press, Madras.
170	Castration and Mulling. Leaflet No. 8 of 1913.	F. Ware, Superintendent, Civil Veterinary Department, Madras.	Ditto.
171	Report on the Civil Veterinary Department, Burma, for the year ending 31st March 1913. Price As. 10 or 1*s*.	Issued by the Civil Veterinary Department, Burma.	Government Printing, Burma, Rangoon.
172	Administration Report of the Bombay Veterinary College and Civil Veterinary Department in the Bombay Presidency, including Sind, for the year 1912-13.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
173	Report of the Civil Veterinary Department, Mysore, for 1912-13.	Issued by the Revenue Commissioner, Mysore.	Mysore Government Press, Bangalore.
174	Quarterly Veterinary Journal of the Punjab Veterinary Association (in Urdu).	Punjab Veterinary Association.	Lahore.

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REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1914-15

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TABLE OF CONTENTS

	Page
Introductory	i
Part I.—The Imperial Department of Agriculture in India—	
1. Office of the Agricultural Adviser to the Government of India	1
2. Tours	1
3. Agricultural Research Institute, Pusa	2
(*a*) Administration	2
(*b*) Training	2
(*c*) Agriculture	2
(*d*) Chemistry	3
(*e*) Botany	3
(*f*) Mycology	4
(*g*) Entomology	4
(*h*) Pathological Entomology	5
(*i*) Agricultural Bacteriology	5
Part II.—Progress in the Provinces—	
1. Bombay	7
2. Madras	8
3. Central Provinces	9
4. Bengal	9
5. Bihar and Orissa	10
6. Assam	11
7. United Provinces	12
8. Punjab	13
9. North-West Frontier Province	14
10. Burma	15
11. Mysore	15
12. Travancore	16
13. Baroda	16
14. Kashmir	17
Part III.—Progress in Veterinary Work	18
Part IV.—Crops and Special Subjects—	
1. Crops	21
(*a*) Rice	21
(*b*) Cotton	24
(*c*) Wheat	28
(*d*) Tobacco	29
(*e*) Sugarcane	30
(*f*) Oil-seeds	33
(*g*) Tea, Coffee and Rubber	35
(*h*) Indigo	36
(*i*) Fruit	37
(*j*) Fibre crops	~~38~~ 39

PAGE

2. Special Subjects 40

(*a*) Agricultural Education 40

(*b*) Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures 42

(*c*) Agricultural Engineering 46

(*d*) Dry-Farming 48

(*e*) Sericulture 49

(*f*) Co-operation 50

PART V.—PUBLICATIONS AND EXPENDITURE—

(1) Publications 61

(2) Expenditure 63

APPENDIX.—LIST OF AGRICULTURAL PUBLICATIONS IN INDIA DURING 1914-15

INTRODUCTORY

IN former years it has been the custom to bring out in the introductory chapter a few of the more notable achievements of the Department. I do not propose to continue this course. The work of the Department has so increased that it is impossible in a mere synopsis to do justice to its various activities. Even now, the space allotted for the Report itself is scarcely large enough to do more than give a very brief and incomplete description of what is being done under the numerous heads and a further contraction would serve no useful purpose. I must therefore leave the public to glean such information as it desires from the report itself.

I have to thank Mr. Wynne Sayer, Assistant to the Agricultural Adviser to the Government of India, for the part he has taken in the preparation of this report.

BERNARD COVENTRY,

Agricultural Adviser to the Government of India

and

Director of the Agricultural Research Institute, Pusa.

PUSA,

February 15, 1916.

REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1914-15

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PART I.

The Imperial Department of Agriculture in India.

1. *Office of the Agricultural Adviser to the Government of India.* Mr. Bernard Coventry, C.I.E., held charge of the combined offices of the Agricultural Adviser to the Government of India and Director of the Agricultural Research Institute, Pusa, during the year under report and Mr. Wynne Sayer, B.A., who was acting as Assistant to the Agricultural Adviser was appointed to the post, Mr. A. C. Dobbs, B.A., the permanent incumbent having been transferred to Ranchi as Deputy Director of Agriculture under the Government of Bihar and Orissa.

2. *Tours.* During the year the Agricultural Adviser to the Government of India, as usual, spent much of his time on tour. He started on his monsoon tour on 4th August, 1914, and inspected the Sugar Factories of Bihar. He visited Gorakhpore, Pilibhit, Allahabad, Cawnpore, Aligarh, Lucknow, Sandila, Shajahanpur, Muktesar, Poona, Bombay, Central India and Ajmer.

From Ajmer the Agricultural Adviser proceeded to Simla where he stayed till 18th October.

He attended at Delhi and Simla the meetings of the Board of Scientific Advice in November 1914, and May 1915, respectively. In 1915 the Agricultural Adviser made a short tour in the Madras

Presidency visiting Madras, Coimbatore, Calicut, Cochin, Koilpatti, Nellikuppam and Palur. He then proceeded to Bangalore.

In February, 1915, he attended the Indigo Conference at Delhi and visited the Bacteriological Station at Bareilly.

The remainder of the year was spent at Pusa.

3. *Agricultural Research Institute, Pusa.* An account of the work in progress at Pusa has been published in detail in the Annual Report of the Institute and it is only necessary here to draw attention to a few points of interest.

(*a*) **Administration.** The only essential changes in the administration of the Institute have been the appointment of Mrs. Gabrielle L. C. Howard, M.A., as Second Imperial Economic Botanist from 10th February, 1915, and the termination of the services of Mr. A. J. Grove, M.Sc., Supernumerary Entomologist, from the 27th April, 1915, and of Mr. G. D. Mehta, L.Ag., B.A., Supernumerary Agriculturist, from 31st March, 1915. Mr. J. H. Walton, B.A., B.Sc., Supernumerary Agricultural Bacteriologist, joined the Indian Army Reserve of Officers on 4th June, 1915.

(*b*) **Training.** There were 6 students undergoing training in various sections in the post-graduate course. Besides, short courses were also given in sericulture and lac culture. In addition to the regular students, facilities were given to three visitors who worked in the laboratories for some time on special subjects.

(*c*) **Agriculture.** The field experiments dealing with the maintenance of soil fertility under double cropping were continued and the green manuring experiments conducted in collaboration with the Imperial Agricultural Bacteriologist altered in accordance with the experience gained.

The steam tackle has proved its value in lightening the work of the staff and allowing for more concentration on experiments and improvements. It has also rendered the task of growing sufficient fodder for the breeding herd a much lighter one. No definite opinion about its economic value can yet be given as correct figures for depreciation and repairs cannot be worked out while the machinery is new.

In the breeding herd the initial steps towards the building up of " milk pedigree " have now been completed, but the results will

only be apparent when the present calves come on to profit. The cross-breeding experiments with the Ayrshire bull were continued with the object of accumulating information relating to transmission of characters.

(*d*) **Chemistry.** Mr. Leather's work on soil temperatures which has been carried on for the last three years was brought to a conclusion and the data obtained embodied in a Chemical Memoir, volume IV, no. 2. It shows that the effect of a covering crop on land is to minimize the changes in soil temperature which are often so inimical to growth and to assist in averaging the day and night normal temperatures. Work on soil gases was also published in Chemical Memoir, volume IV, no. 3, from which the author claims that the value of surface cultivation so far as it concerns the promotion of the aeration of the soil thereby producing and accelerating root growth is greatly overestimated and that the value of cultivation of the surface soil must be attributed to other causes.

The work on sugar at Peshawar has resulted in a definite proof that cane could be safely 'clamped' until the end of March without suffering any deterioration and this would enable a sugar factory to keep running for a longer period.

Work has also been done on saltpetre and milk while the possibility of manufacturing starch economically from Indian materials received attention.

(*e*) **Botany.** In the Botanical Section the work on the improvement of some important crops and their methods of cultivation was continued. The progress made has been described in detail in Part IV of this Report. In connection with wheat work it is of great interest to notice that Pusa 12 and Pusa 4 have given good results in the Argentine while favourable reports have also been obtained from Egypt and the Sudan, which make it seem probable that in the future Pusa may prove of use as a wheat breeding station for the warmer wheat-growing areas of the world.

The results of the indigo experiments so far undertaken seem to point to the fact that the problem of 'wilt' is solved.

Work on gram, fibres and oilseeds has produced results of considerable importance which are being published in Memoirs.

A sample of fibre from *Patwa* (*Hibiscus cannabinus*) carefully retted and prepared was sent for valuation to Messrs. Wigglesworth for report and was valued at £18 per ton compared with the usual £8 for ordinary fibre.

(*f*) **Mycology.** The work on 'ufra' was continued and experiments were made both at Pusa and Comilla with a view to eradication of this disease. The experiments will be repeated next year with additional precautions as this year's experiments were rendered inconclusive owing to a deficiency of water in the experimental area at Comilla. The diseased area this year is much the same as last year, but investigations on observed paddy at Balasore and Bankipur did not disclose the presence of "ufra."

Work on the 'Black Thread' disease of rubber in Lower Burma was taken up and experiments are still in progress. *Sal* tree disease was also investigated and the work on *Rhizoctonia* was published as Botanical Memoir, vol. VII, no. 4.

Further research experiments were conducted into the blight of the opium poppy with a view to discovering whether *Rhizoctonia* or *Peronospora* was the chief cause of this disease.

(*g*) **Entomology.** Crop pest investigations were continued with a view to ultimate control of such pests as the cotton bollworm, the sugarcane borer, while much time was spent in dealing with an outbreak of *Maho*, the rice leaf hopper, in the Central Provinces. Putting up lantern traps in the affected fields was found to be the most efficacious method of dealing with this pest and the cultivators readily adopted this measure.

Fruit-flies have been reared in large numbers from various fruits in order to procure parasites and to ascertain the proportion parasitised. Tests on the effect of poisoned sprays on fruit flies were also carried out to ascertain the most efficacious and economical mixtures.

The work on silk was continued and the attempts to establish a superior stable multivoltine hybrid race which will not degenerate were proceeded with and silk exhibits were sent to exhibitions held at Muzafferpur, Monghyr, Pudukottai, Mysore and to Calcutta, Madras and Cawnpore in connection with the exhibition of Indian as contrasted with German and Austrian goods.

The experiments with bees during the year showed that out of the three principal defects of the Indian bee in the plains, *viz.*, deserting the hive in autumn, inability to defend the hive against the wax moth and frequent swarming, the two former can be remedied but the efforts made to check frequent swarming were not successful. A Bulletin on bee-keeping was issued at the close of the year. An Entomological Conference was held at Pusa from 2nd to 8th February, 1915, and on this occasion the opportunity was taken to extend the scope of the meeting to embrace others engaged in similar entomological work in other departments. It is hoped that similar meetings may be held regularly in the future.

(*h*) **Pathological Entomology.** Work on three main lines of enquiry was carried on in this section, all having regard to the ultimate control of insects injurious to man and cattle. The lice of sheep and goats were investigated and a lime sulphur wash followed by a vinegar spray was found to give excellent results.

A campaign against mosquitoes on 'control breeding' lines was carried out at Pusa and proved a great success. A survey of the Kathgodam Surra area was made for blood-sucking flies. The life history of three horse flies was worked out during the year.

(*i*) **Agricultural Bacteriology.** The work on the bacterio-toxins in soils was continued and carried a stage further. The inhibition of nitrification in water-logged soils was found to be due rather to the action of toxins resulting from certain classes of bacteria which thrive under these conditions than to lack of oxygen merely. It was found that germination in a water-logged soil was interefered with owing to the rapid reduction of nitrate which takes place under such conditions, and it seems probable that the toxins produced under these conditions would not only affect the germination and growth of seedlings but also alter the character of the soil complex so as to promote reduction of nitrates to nitrites for just so long as this abnormal character persisted.

Nitrate formation in field plots under different crops has been under observation, and grass has been found entirely to prevent accumulation of nitrate in the soil over which it is growing.

This would have bearing upon the universal action of grass towards the growth and development of trees.

The effect of temperature upon nitrification in Pusa soil was tested, the optimum being found to be near 35° C., while no nitrate was formed at 40° C. nor did any nitrification take place in soil which had been kept at 40° and afterwards lowered to 35°. Further experiments are being carried out to determine the cause of this apparent lowering of the thermal death point.

The comparison of *seeth* water made from *sanai* with the actual *seeth* itself led to some interesting conclusions. The value of the *seeth* water proved roughly equal to the *seeth* itself in application to the *rabi* crop but the residual effect of the *seeth* itself on the succeeding *kharif* crop proved its superiority over the *seeth* water.

The work on fermentation organisms relating to Bákhar was made the subject of Bacteriological Memoir, volume I, no. 6. The relations between amylo ferments and the Saccharomycetes involved in this question are still being studied.

Yeasts and saltpetre also came in for study and a Memoir on the subject of Potato Rot was concluded during the year.

PART II.

Progress in the Provinces.

1. *Bombay.* Mr. G. F. Keatinge, C.I.E., I.C.S., remained in charge of the Department throughout the year. There was a considerable change of staff in the upper rank owing to leave vacancies.

The Department continued to make progress in the development of activities in various directions referred to in last year's report and a considerable move forward has been made especially in gaining the confidence of the people. This is particularly evident from the fact that individuals have come forward with generous contributions for the furtherance of work which was likely to suffer owing to the present financial stringency, sums to the value of Rs. 60,000 having been received or promised.

Besides the progress in the work on some of the special crops like cotton, sugarcane, fruits, etc., and in the spread of agricultural knowledge among cultivators which has been described in Part IV of this report, considerable advance has been made in effecting improvements in general farming matters. The continued spread of iron ploughs has brought about a marked change in the general cultivation in many tracts, while the use of artificial manures on valuable garden crops such as sugarcane, potatoes, onions and plantains is gradually increasing. A start has been made in introducing a scheme for providing a reserve of good fodder against famine in tracts where valuable cattle require protection. This appears to be one of the best forms of help which is likely to be of very great use in effecting improvements in cattle breeding and if the scheme proves economical, it will be possible to extend it. Another line of work which offers a scope of profitable development is the attention paid to the conservation of soil of the vast areas of uplands and sloping lands which either produce practically no crops in dry years owing to want of moisture or are washed away in years of heavy rainfall. One possible method of improving such soils is by effective field embankments and arrangements

have been made to study this question and to obtain experience in this line of work.

In the engineering branch, progress continued to be made in the increased use of economical means for lifting water. There are now several large pumping plants erected by the owners with the intention of selling the water to surrounding cultivators, while, as a result of successful boring work in Gujerat a marked increase in the area of land irrigated is anticipated.

2. *Madras.* Mr. D. T. Chadwick, I.C.S., was in charge of the office of the Director of Agriculture throughout the year.

The special features have been described as follows in the Proceedings of the Board of Revenue no. 215, dated 28th July 1915 :—

> The most notable events of the year were the admission of twice the usual number of students to the Agricultural College as a result of the institution of the new courses, the holding of an Agricultural and Trade Conference in Madras in December 1914, and the receipt of the Secretary of State's sanction to the reorganization of the Department. This last provides for seven divisions in the Presidency, the establishment of more district agricultural stations, the recruitment of a trained district staff in every district, the co-ordination of the prospects of assistants in the scientific sections of the college with those of men on the executive staff and a general improvement in the pay and prospects of most of the men in the service.

The activities of the Department during the year were mainly directed towards the selection and distribution of seed of the best varieties of crops more especially rice and cotton, the two most important crops of the Presidency, the reduction of seed-rate with a view to the economic transplantation of paddy, and the use of manures for sugarcane and rice. The progress made in all these directions has been very marked as will be seen from the account given under respective crops.

The campaign against palm-disease in Godavari and Kistna districts was continued and the method of combating it referred to in last year's report was persevered with. Under this method not only are dead and diseased trees operated upon but a system of examining all the trees in the infected area has been introduced. This is calculated to give more satisfactory results as an infected tree can remain a source of infection to others for years. As a

result of such detailed examination 27 villages in Kistna were removed from the infected list at the end of the year.

3. *Central Provinces.* Mr. C. E. Low, C.I.E., I.C.S., held charge of the office of the Director of Agriculture and Industries up to 30th November 1914 and from 1st December Mr. C. G. Leftwich, I.C.S., took over charge. The remaining vacancy in the superior staff has been filled up by the appointment of Mr. R. I. Harvey, as Assistant Director of Agriculture.

The Department has continued to make great progress in the development of co-operative organizations referred to in previous reports not only for demonstrating improved methods but also for the production and distribution of a large quantity of seeds. This has resulted in a rapid expansion of rice transplantation work in Chhattisgarh, in the cultivation of *roseum*-cotton in Berar and of superior varieties of wheat in the Northern Division all of which have now assumed huge proportions. Besides this, superior varieties of rice, sugarcane and oil-seeds are replacing local kinds in various places while there is a rapid expansion in the use of smaller improved implements for agricultural purposes. The new agricultural research laboratory has been completed and will now enable investigations to be carried out by the Economic Botanist on various important crops. He has already taken up researches on *jowar* and wheat, and the classification of rices.

Another feature of development in these provinces relates to the progress made in improving the various breeds of cattle. There are already three Government cattle farms and a fourth was opened during the year for the improvement of the Khamgaon breed in Berar. Besides, there are various co-operative and private breeding farms conducted under the advice of the Department.

4. *Bengal.* Mr. J. R. Blackwood, I.C.S., remained in charge of the Department throughout the year. The post of second Deputy Director of Agriculture was filled up by the appointment of Mr. K. McLean towards the close of the year.

The work of this Department has suffered most owing to paucity of expert staff. For a long while there was only one Deputy Director for the whole Presidency and it was impossible

for him to direct with any measure of success the experimental and demonstration work throughout, which is so essential for any material progress. It is useless to attempt to do any experimental work which is not the outcome of careful study of local requirements, and until experiment and research have been successfully carried out on local farms, it is no use attempting demonstration work. More expert staff is therefore required.

Some progress has however been made in spreading the use of bonemeal as a manure for paddy and jute and in the introduction of superior varieties of paddy, sugarcane and potatoes. The work which is being done by Mr. Hector on rice and by Mr. Annett on sugarcane and date palms promises to be of considerable importance. A scheme is being gradually worked out to save the silk industry by supplying all the seed needed for the Province free from disease. An improvement has been effected in the work of preparing the jute forecast which promises to do well. Mr. Southwell, Deputy Director of Fisheries, is making important investigations relating to the increase in the fish supply of the Province which at present falls far short of the local demand. He has been successful in supplying a large quantity of carp-fry to the public and is attempting to bring the Fishery Department in touch with the co-operative movement.

5. *Bihar and Orissa.* Mr. G. Milne, I.C.S., was in charge of the Department during the year except for 40 days. The superior staff was strengthened by the addition of two Deputy Directors, one Assistant Director and one supernumerary Assistant Director. Mr. Woodhouse, the Principal of the Sabour College and Economic Botanist, and Mr. McGowan, the Professor of Agriculture, joined the Indian Army Reserve of Officers in March 1915

Experimental work was done as usual at four agricultural stations and in addition a new station was opened near Ranchi to serve the needs of the Chota Nagpur Division. Rice, wheat and sugarcane were the crops which received the most attention and superior varieties of them were distributed in various localities. With the additional expert staff it will now be possible to study the needs of the particular localities more closely and then to direct the experimental and demonstration work accordingly under proper control.

Campaigns against 'Greasy surface Caterpillar' were conducted at Mokameh and in Bhagalpur where a large number of moths were caught with Andres maire traps. The extent of damage done by the pest was 2,000 bighas at the former place and 165 bighas at the latter.

The Fishery Department which was in charge of Mr. T. Southwell, Deputy Director of Fisheries of both the Governments of Bengal and Bihar and Orissa, carried out extensive investigations in order to discover the most suitable methods for artificially hatching carp and hilsa for which hatcheries have been established at Cuttack and Buxar. The work is still in an experimental stage. A steam launch has been constructed and it will now be possible to conduct investigations into the habits of hilsa.

6. *Assam.* Mr. J. McSwiney, I.C.S., held charge of the Department for the whole period with the exception of some four months during which Mr. A. R. Edwards, I.C.S., was in charge. Mr. A. G. Birt, Deputy Director of Agriculture, joined the Indian Army Reserve of Officers in May 1915, making over charge to Mr. A. A. Meggitt, the Agricultural Chemist, who could not devote himself entirely to his own duties as his laboratory has not yet been completed. Rai Bahadur B. C. Basu acted as an additional Deputy Director pending the appointment of a Second Deputy Director, which is awaiting sanction. The Province has also a share in the services of the Fibre Expert and the Economic Botanist, Bengal. The subordinate staff consisted of 24 officers as against 18 in the previous year, but it is not yet sufficient to meet the requirements of the Province. Arrangements have however been made to train a larger number of apprentices on the farms and to raise the number of scholarships open to natives of the Province at the Sabour Agricultural College. There were 5 experiment stations devoted to rice, potato, sugarcane, fruit and soil problems.

Mr. Meggitt continued his investigations on the general question of the use of lime on the sour old alluvium of the Assam Valley and also of organic matter and phosphoric acid in conjunction with liming. Organic manures have been found to play an important part in such soils and work is in progress

to find out the best green manure crop to meet certain conditions. Another problem for investigation which has come to light during this soil work is the presence in it of a compound specially toxic to many crops and it will be necessary to determine the conditions favourable to its formation in dangerous amounts and the methods which will prevent such formation.

The use of bonemeal as a manure for rice is rapidly increasing and a plant has been installed at the Upper Shillong Farm for crushing bones obtainable locally. Superior varieties of sugarcane and potatoes, green manures for paddy and cane, the conservation of cowdung, the growing of *jowar* for fodder, Meston ploughs and iron sugarcane mills are being introduced in the plains, while in the hill tracts superior varieties of potato are gaining favour and efforts are made to extend terrace cultivation.

Honorary correspondents have, as in former years, been the chief agents for disseminating improvements. It has not yet been found possible to effect closer relations with the co-operative movement.

7. *United Provinces.* The Hon'ble Mr. H.R.C. Hailey, I.C.S., remained in charge of the Department throughout the year. There was no change in the superior staff except the appointment of Mr. W. N. Harvey to the post of third Deputy Director of Agriculture which has enabled the opening of a new farm in the Gorakhpur District which will be the headquarters of the new South Eastern Circle.

The main lines of work have been, as stated in the last year's report, the developing of relations with local bodies through which the results already available may be introduced into the agriculture of the Province. The year however has not been a favourable one for making any material progress in some of the branches. Low prices of cotton interfered with the schemes of popularizing desirable types of some important crops while difficulties in procuring pumping plants not only checked the marked progress in the use of mechanical power for pumping in some districts but also restricted the work of the boring department. Considerable progress however was made in the direction of arousing interest among large land-holders in Oudh who have opened large farms for the production of seed in appreciable

quantities. This is an important advance from the point of view of relieving the Department of most of the seed production work. These private seed farms will be most useful in the work of replacing country wheats by Pusa 12 for which there was an unprecedented demand last year.

Among crops, wheat, cotton and sugarcane continued to receive the most attention. Pusa wheat No. 12 has proved most suitable for the greater part of these provinces and has been definitely adopted for distribution. With a view to bringing this wheat to the notice of the Home Millers a beginning was made by sending a shipment in June last for trial in the United Kingdom. The type of Aligarh white flowered cotton isolated by Dr. Parr is increasing in popularity in the western and parts of central districts although the demand for seed was small as compared with previous years owing to the general unpopularity of the cotton crop on account of the prevailing circumstances. In sugarcane work, Mr. Clarke has obtained promising results at the Shahjehanpur farm with a variety known as Java 33. It appears to possess qualities fitting it for general cultivation and is being tried in different parts of the provinces. The indigenous canes are gradually being sorted out and a selection made of those most suitable for particular localities. Mr. Clarke is also experimenting with a small power mill for crushing capable of being taken up by small zamindars.

Besides sugarcane, wheat and cotton, the work on which is on a progressive scale, two other crops, *viz.*, barley and poppy, have been taken up for study, the former for ascertaining the causes of the defect which led to the complaint from Home that some of the shipments of Indian barleys exported for malting contained a large percentage of grain which would not germinate, while the latter with a view to determining the causes of a somewhat widespread disease in poppy and to finding out the possibility of producing a variety with a higher morphine content.

8. *Punjab.* Mr. W. S. Hamilton, I.C.S., was Director of Agriculture till 26th November 1914, when Mr. C. A. H. Townsend, I.C.S., took charge. The post of third Deputy Director of Agriculture was filled up by the appointment of Mr. O. T.

Faulkner who has been put under training at Lyallpur. Mr. Southern, Deputy Director of Agriculture, joined the Indian Army Reserve of Officers. The scale of pay of Agricultural and Research Assistants was improved and this had an excellent effect in increasing the popularity of the Agricultural College.

Considerable advance has been made in the three principal lines of work on which the activities of the Department are mainly concentrated, *viz.*, the demonstration and sale of improved implements and the spread of improved wheat and cotton seed. The Government has sanctioned various special leases of land in the Lower Bari Doab Colony for purposes in which the Department is acutely interested, *e.g.*, growing of selected cotton and wheat seed, cattle breeding, etc. Owing to adverse circumstances it has not been possible to make use of co-operative societies but some Union Banks have undertaken the sale of implements while others have purchased wheat seed and are storing it. Iron ploughs have been sold in considerable numbers, whilst a keen demand has arisen among enterprising zemindars in the canal colonies for reapers and threshers.

Mr. Barnes, the Agricultural Chemist, has obtained very promising results in his experiments on the reclamation of "kalar" land and it is hoped to take up the reclamation of such lands in any part of the Province at a fixed sum per acre. He also carried out investigations on wheat weevil in collaboration with Mr. Grove, the late Supernumerary Entomologist, who was specially deputed to the Punjab for this work. The results are being published as a memoir and will be of great use in connection with wheat elevators which will no doubt come into use at some future time in the colony areas.

Apiculture continued to receive attention at the hands of Mr. Cousins, whose activities are at present confined to the extension of the bee-keeping in the hills. He disposed of 4 colonies of bees in the hills and as a result of his advice and lectures frame hives are being adopted.

9. *North-West Frontier Province.* Mr. W. Robertson Brown remained in charge of the office of Agricultural Officer of this Province. He continued to make progress in the development of fruit trade of the Province and to establish superior varieties

of crops found successful on the Peshawar Agricultural Station. Pure stock of wheat which is most valued in the Peshawar valley has been propagated and extensively distributed and some selections have been made in barley with a view to establishing one type in the lower valleys of the Province.

A very good orchard is maintained at the Peshawar Agricultural Station and as a result of distributing superior varieties of fruit trees from this source and of encouraging better orchard cultivation, a marked improvement is visible in fruit growing around the Station.

Experiments with sugar beets have further confirmed the results previously obtained that beets of high quality can be produced in the Peshawar valley. Arrangements are now being made to ascertain if cultivators in the valley would grow the crop for a factory.

10. *Burma.* The post of Director of Agriculture was held by Mr. H. Clayton, I.C.S., who was also Joint-Registrar of Co-operative Societies. A post of third Deputy Director has been sanctioned, but it is not proposed to provide funds for this appointment until the conclusion of the war.

A new experimental station was opened in the Southern Shan States making a total of eight in the Province. A large amount of preliminary work has been done on these stations with the important crops of the localities with the object of selecting superior types, and unit strains of some desirable types in paddy, cotton and some pulse crops have already been isolated. As soon as the breeding work advances and the pure lines of improved quality are available in sufficient quantity for distribution, a considerable development in the district work is to be expected. In the meantime closer relations with co-operative societies are being established. A good deal of seed production work has already been handed over to the members of the Hmawbi Co-operative Credit Society. District Agriculturists are at work in ten districts and two seed farms have been sanctioned as an experimental measure to demonstrate the value of improved seed.

11. *Mysore.* The Department of Agriculture in this State remained in charge of Dr. L. C. Coleman, M.A. He is assisted by a Deputy Director and an Assistant Director in agricultural

work and by assistants in various branches. An Agricultural Engineer has also been appointed to take charge of irrigation and drainage work and the introduction of improved agricultural implements.

While progress continued to be made in the agricultural section chiefly in popularizing improved cultural methods in paddy, superior varieties of sugarcane and methods of *gul* manufacture and the use of iron plough, an important advance is perhaps that made in controlling the important diseases and pests of plantation and other crops such as coffee. The methods of combating Koleroga of the arecanut have been practically standardized and the work of stamping out the disease in isolated areas gives a great promise of success. Similarly the work of bringing the Green Scale of coffee under control has been vigorously taken up. This pest has extended very widely during the year so that practically the whole of the coffee area in the State has been infested. Spraying with the fish oil resin soap mixture has been found to take a prominent part in controlling this pest and investigations to this end have been taken in hand.

12. *Travancore.* Dr. N. Kunjan Pillai, M.A., B.Sc., remained in charge of the Department in this State. He had the help of assistants in all branches except Mycology. The main progress has, as in the previous year, been in the popularization of manures for cocoanut and rice, of methods of single seedling transplantation of rice and the use of light iron ploughs. Among crops, the cocoanut continues to receive by far the greatest share of attention. The root disease is being kept under control chiefly by the destruction and segregation of infected trees, the propagation of disease-resisting varieties and by advising the ryots to pay proper attention to cultivation and manuring so as to improve the general condition of the palms. The last named device is being attended with increasing success. The manurial experiments on this crop have so far given very promising results, the yield of nuts steadily rising year by year.

13. *Baroda.* Mr. M. N. Sitole, B.A., M.R.A.C., remained in charge of the Department as Director. The subordinate staff of the Department consists of Superintendents of model and de-

monstration farms, Agricultural Inspectors and an Entomological Assistant. Agricultural associations have been started in various places and have done useful work in introducing iron ploughs and seeds of selected varieties of cotton and groundnut. Successful demonstrations of improved methods of agriculture were also held on the farms of the State.

Progress continued to be made in reclamation of ravines by dams and terracing and during the last two years about 800 *bighas* have been reclaimed. In order to encourage extensive irrigation, the Darbar gives Takavi advances to keen cultivators for purchase of oil engines and pumps and during the last two years some 28,000 rupees have been advanced for the purpose.

14. *Kashmir.* Mr. Ram Gopal, M.A., M.R.A.C., remained in charge of the Department of Agriculture of this State during the year.

The work of this Department is still in an experimental stage. Trials are in progress on the model farm with various crops and with manurial experiments on them. This experimental work has, in some cases, already given results which are worth introducing into the agriculture of the State, but the absence of any district staff has prevented any successful demonstrations being arranged. A proposal for recruitment of this staff and for an assistant for plant diseases is now under consideration.

Co-operative agricultural banks in village communities were started and these will, it is hoped, be of considerable use in furthering the work of the Department.

PART III.

Progress in Veterinary work.

The table opposite gives a bird's eye view of the organization of the Provincial Veterinary Departments and the progress made during the year. The number of dispensaries, the total number of patients treated and inoculations made have increased as compared with those of the previous year, and there is an increasing demand for opening new dispensaries. In Bombay, several District Boards have applied for necessary assistance to enable them to increase the number of dispensaries in their districts. This indicates that the Department is gaining confidence of the public. The work of the Department is sometimes hampered owing to the ignorance of the people and their prejudice against inoculation. This complaint came specially from Bengal and Bihar and Orissa where heavy mortality in cattle is attributed to these causes. Sometimes an outbreak of the disease is not reported in time and the disease becomes uncontrollable. This is partly due to the laziness of the people and partly to the negligence of the officers whose duty it is to report such information. It is however gratifying to note that in some provinces the prejudice is dying out rapidly. In Bombay, the people sometimes voluntarily report to Government officers the appearance of a disease in the locality. In almost all provinces steps are being taken to ensure prompt supply of information regarding the outbreak of a disease to Government officers.

During the year under report, in all provinces except the Central Provinces, outbreaks of rinderpest were more widespread than in the previous year. In Bombay, and Madras, the disease appeared in a very virulent form, but efforts were made to combat the disease by means of inoculation and distribution of pamphlets. In Bombay, inoculation work was taken up on a very large scale with satisfactory results. Out of 54,223 animals that were inoculated only 262 died whereas 4,046 uninoculated contact animals died of the disease. It is satisfactory to note that people are now beginning to appreciate the advantages

Province	No. of superior staff	*Veterinary Colleges and Schools*			*Dispensaries and hospitals*		*District staff and work*						
		Research	No. of students at end of year	No. of subordinate teachers	No. of dispensaries	No. of cases treated in hospitals and dispensaries in the year	No. of Inspectors	No. of veterinary assistants	No. of outbreaks in which inoculation was undertaken	Cases treated and castrations performed on tour	Deaths uninoculated	Inoculations	Deaths after inoculation
Punjab	11+4*	Examination of specimens and diagnosis.	126	...	121	319,979	18	187	321	79,168	4,231	59,148	95
Assam	1	*Nil*	...	...	2	4,214	3	41	184	73,301	4,279	21,117	247
Burma	3+6†	Diagnosis and examination of specimens.	51	1	1	1,374	14	141	89	77,829	446	9,649	182
Bombay	4+6‡	Diagnosis	70	...	52	126,915	4	63	303	28,297	4,046	54,311	262
Sind	1+1†	*Nil*	...	..	12	15,706	1	13	23	2,554	483	3,084	7
Ajmer-Merwara	...	*Nil*	...	...	2	1,540	...	3	5	365	119	1,076	..
Baluchistan	...	*Nil*	...	...	4	3,274	1	4	1	1,402	31	196	4
United Provinces	2+2†	Examination of specimens, diagnosis, kumri, barsati and other diseases.	...	...	61	67,802	19	158	1,170	79,655	7,031	78,194	63
Bengal	3+6†	Diagnosis, examination of specimens, preparation of vaccines.	72	6	24	24,049	16	81	387	53,287	4,782	41,080	229
Bihar and Orissa	1	*Nil*	...	...	20	20,044	8	61	726	53,613	6,883	130,028	427
North-West Frontier Province	...	*Nil*	...	...	19	58,617	2	26	69	15,456	246	14,331	13
Madras	2+2§	.....	51	3	28	28,636	7	82	486	26,481	10,592	98,455	219
Central Provinces	2+2†	Protozoal infections	...	...	78	132,254	12	99	465	103,350	5,044	49,931	112
TOTAL FOR 1914-15	59		370	10	424	810,404	105	959	4,229	594,758	48,213	560,600	1,860
TOTAL FOR 1913-14	57		364	10	393	737,999	95	914	3,351	604,993	41,246	462,009	1,076

* Two Indian Professors, one House Surgeon and one Deputy Superintendent.
† Deputy Superintendents.
‡ Two Deputy Superintendents and four Indian Professors and Assistant Professors.
§ One Deputy Superintendent and one Assistant Principal.

of inoculation as a preventive measure. In Sind, several cattle owners voluntarily got their cattle inoculated when the disease appeared in their villages.

In the Punjab, special arrangements were made during the Amritsar, Dewali and Baisakhi fairs to detect and also to prevent the spread of Glanders. All the cattle that were brought there, were scrupulously examined and the purchasers were warned to keep the animal purchased under segregation for a month. In Bombay, a Veterinary Inspector has formed an "Emergency Corps" from reserved men under training in his Division to undertake inoculation and other necessary work. This is found to work satisfactorily.

Efforts to improve the breed of cattle by means of cattle breeding farms and supply of bulls for breeding purposes have been continued. The sheep breeding experiments undertaken in the United Provinces referred to in the last year's report have given encouraging results. The introduction of the merino strain has been found to improve the quality and quantity of the fleece. It is therefore proposed to establish a sheep-breeding farm in these provinces to demonstrate to the public the advantages of careful selection and breeding. In the Punjab also the demand for merino is on the increase.

In the Madras Presidency, the system of utilizing the services of veterinary assistants for the inspection of meat mentioned in the previous report has received the support of the Sanitary Commissioner to the Government, and several municipalities in the Presidency have agreed to adopt it. The subject of meat and milk inspection has also been included in the curriculum for the diploma examination of the Madras Veterinary College.

Research work on Rinderpest, Anthrax, Hæmorrhagic Septicœmia and other diseases was continued at the Muktesar Laboratory and 132 specimens were received for examination. This laboratory suffered a heavy loss on account of the untimely death of Lieutenant-Colonel J. D. E. Holmes, Imperial Bacteriologist, which took place in February 1915. During his seven years' tenure of office as Imperial Bacteriologist he worked indefatigably and attained results which have been of great value to the country.

The new centrifuges indented from England have not arrived as yet. The Laboratory however managed to meet the demands for sera by constant repair of the old centrifuges. The demand for sera and vaccines has increased. The most noticeable increase is in the case of Anti-rinderpest serum which considerably exceeded the record of any previous year, the quantity issued being 1,382,050 doses or 22 per cent. more than the next highest figure in 1912-13. During that year, however, 17 per cent. of the total quantity issued went to foreign countries while in 1914-15, only 3 per cent. were supplied out of India; so that comparing the quantity issued in India during these two years the increased consumption during 1914-15 amounts to 43 per cent. This shows that the demand for the serum is rapidly increasing in India and it is evident that it will increase still further as the results of serum application become more widely known.

PART IV.

Crops and Special Subjects.

1.—Crops.

(*a*) **Rice.** Three main lines of work still dominate the research on this important crop, *viz.*:—

(*a*) *Scientific research.* This is mostly being done with a view to evolving types giving increasing yields and hardier plants capable of withstanding the different conditions under which this crop may have to be grown both owing to situation and unforeseen circumstances and to determining the factors which affect the yield and quality of grain.

(*b*) *Improvement in cultural methods.* This branch of the work economizes the seed rate and materially assists the cultivator by giving him a larger return for a smaller outlay.

(*c*) *Manuring.* Thorough research on this point should enable the best results to be obtained from selected varieties and it is here perhaps that most can be done in the immediate future, both by introducing the best manures and by stopping the ryot from obtaining expensive and unsuitable manures whose effects are only too liable to lessen his confidence in the selected strains, for, in the words of the Director of Agriculture, Madras, speaking of artificials, "it is above all things important that the ryot only gets the substance he requires and gets it pure."

Research. In Madras, the Economic Botanist is working on the problem of evolving better single strains. The work has only recently been started and it will take time before it yields practical results, but some important facts concerning the varieties such as the extent to which the ordinary varieties in the ryots' fields are really true to type, the importance of uniformity

in ripening of plants of any one pure strain and so on, have come to knowledge. Dr. Harrison continued his researches on the gases of swamp paddy soils and their utilization for the aeration of the roots of the crop, and a further account was published in the Memoirs of the Department of Agriculture in India, Chemical Series, volume IV, no. 1. The general result of this work goes to show that "green manure crops have not so much direct manurial value on paddy as has been imagined but have a very important influence on the healthy growth of the crop by improving the aeration of the water and soil, by improving the mechanical texture of the soil and by promoting biological action."

The breeding experiments in Bengal have progressed a little further and Mr. Hector has begun testing several of his selections on a practical scale. The yields of these have been very favourable and the next step would be to introduce them in suitable areas.

Similarly, in Burma, pure strains of improved paddy giving much higher yields than local strains are now ready for distribution. Some of these strains have been reported on by the trade as best suited for export while others as specially fit for export to India and for local consumption. The Agricultural Chemist continued his investigations on the effect of climate and watering on the ripening of paddy. The data obtained are not yet conclusive.

In the Central Provinces, Mr. Graham continued his investigations of the rice crop, a preliminary note on which was published in 1913 as Botanical Memoir, vol. VI, no. 7. Selected strains are being tested on Government Farms. He has also taken up a systematic study of the wild rices, over 100 specimens having been collected and grown.

Improvements in cultural methods. It is in this line that great development has taken place throughout and the question now is to extend the operations year by year till the whole tracts are covered with the improvement. In Madras, it has been proved beyond doubt that by reducing the seed rate of rice (in order to ensure seedlings coming up healthy) and then by single

seedling transplantation there is not only a great saving in seed but the outturn is also considerably improved. The practice is therefore vigorously pushed forward and has already spread considerably. Among the experiments with thick and thin sowing of seedbeds, the result showed that while the usual thick sown seedbed has 700 lb. seed to the acre, experiments with 350, 280 and 210 lb. per acre gave an yield of 3,513, 3,648 and 4,066 lb. grain and 6,438, 6,526 and 6,493 lb. straw per acre respectively, thus proving that while straw remains pretty even the grain yield is definitely in favour of the thinly sown seedbed. The practice of single seedling transplantation has also become popular in Travancore where demonstrations are being carried out. In manurial experiments which are being carried out in the Madras Presidency with a view to discovering the most efficient and economical manure, there is an increasing mass of evidence to point out that green leaf in bulk supplemented by phosphate in some form is the most suitable manure. But there are certain localities where apparently addition of phosphate does not pay. The time and method of application however is bound to be of great importance and requires further study. In the meantime the practice of green manuring is making an advance in suitable tracts.

In Travancore, the results of six years' manurial experiments have proved the value of locally available manures such as oil-cakes, bonemeal, fish manure and the like and the Department has opened a number of manure depôts for selling them.

In the Central Provinces, attention is being chiefly directed to the improvement of rice in the Chhattisgarh districts and to this end the substitution of transplanting for broadcast sowing is being put forward as also the eradication of the various wild rices which "pollute the paddy of every village." The questions of optimum quantity of water for irrigation and spacing distances in sowing are also receiving attention. The area transplanted rose from 30,000 acres in 1913-14 to 40,000 acres last year and the average yield of crop experiments made in 90 villages to compare the outturn of transplanted rice and the rice sown with the local method was 869 lb. in favour of transplantation. The work is pushed on with the help of the Revenue staff, the

Agricultural Department being responsible for the quality of the work. This arrangement has been found to work well.

Diseases and pests of rice. Various pests and diseases are known to attack the rice crop, but the important ones which engaged some attention during the year under report were "ufra" disease in Bengal and "maho" caterpillar in the Central Provinces. The experiments to find some means of checking the former were continued but have not given conclusive results. They consist of firing the surface of the soil, but Mr. Hector has also begun experiments to find out if there are varieties which by their habit of early ripening may escape the virulence of the disease. With regard to "maho" insect, this pest caused much damage in Chhattisgarh, in some villages more than 25 per cent. of the crop being eaten away. An assistant was sent from the Pusa Entomological Section to apply remedial measures and of the various means tried that of destroying the adult insect by the use of light traps proved to be most successful.

(*b*) **Cotton.** The work on this crop has gone on steadily on the lines laid down in last year's report, the main advancement being in the increase of seed farms and in the improvements on the methods of distribution which will materially lighten the labour of those who have been engaged in the essential spade work for the improvement of the crop.

In almost all the cotton-growing provinces, there already exist types of country cotton got after selection on broad principles and found to be superior to prevailing mixtures either in quality or yield, or both, and pending the evolution of more improved strains by purely scientific methods, the introduction of the already available forms is being pushed forward. The question of permanent improvement is therefore largely a matter of efficient District organization so as to control the seed supply which is most essential in case of the cotton crop where owing to various causes seed is liable to be mixed and the work of improvement upset. In order to minimize the chances it is absolutely necessary to organize the work in such a way as gradually to replace the country crop by the improved kind over definite areas. This is the aim with which the Departments are now working with schemes suited to local conditions.

In the Central Provinces, the seed of *roseum* cotton is being distributed through the agency of Co-operative Agricultural Seed Unions which maintain a central farm and also branch farms for the production of this seed. There were 11 such registered and 19 unregistered Unions besides 71 other seed farms during the year. About 1,553,000 lb. of seed capable of sowing 200,000 acres was distributed through these agencies; besides a large quantity (345,000 lb.) was disposed of by several cotton growers themselves without any assistance from the Department. The great superiority of this cotton both in yield and ginning percentage over the local cotton has now been universally established in Berar and the success in its spread throughout the districts has been phenomenal.

In the Madras Presidency, the lines on which work is in progress are :—

(*a*) the general improvement in the purity of the crop by selling seed from bulk selections;

(*b*) the testing, development and distribution of unit strains;

(*c*) the fostering of co-operative sale of pure crops direct to the large firms; and

(*d*) the spread of the use of the seed-drill and harrow.

The work of seed production is done on private seed farms by contract growers and the seed is sold to ryots from seed depôts in the sowing season. In 1914-15, the departmental seed was sold off at 20 per cent. above ordinary bazaar rates and about 20 to 22 thousand acres were under the improved type in Tinnevelly District alone which means double the area obtained in the previous year. The bulk selections are being slowly replaced by unit strains which have been very favourably reported upon by the trade. The fact that some of the mills are paying a bonus of Rs. 2 to 3 per 250 lb. of lint in order to secure the crop is a very good testimony to their value.

The system of joint sale of seed cotton by cultivators in a number of villages direct to the firms is anticipated to be capable of very great possibilities both as a means of profit for the cultivator and as a means of spreading new types. The mills are

helping this movement by agreeing to gin such joint consignments separately from those of any one else. The formation of Co-operative Societies to further this scheme has not yet been possible.

Concurrently with the distribution of improved seed, the use of drill and harrows for cotton cultivation in the Tinnevelly District is also extending. The area on which these implements were used by ryots themselves rose from 7,000 acres in 1913-14 to 11,300 in 1914-15. Arrangements have been made to train more cultivators in the use of these implements and thus do away with the necessity of employing trained coolies for the work.

Selection work on Cambodia cotton has begun and large quantities of selected seed were distributed in suitable places. This cotton is also being pushed forward in the canal tracts of Mysore where it has done well.

A beginning has been made in Mysore in selecting suitable strains from among the local varieties, as the varieties which were introduced from outside (Broach and Nandyal) and which did well for some years in the beginning have, with unfavourable seasons later on, fallen in yield very much below that of local cotton.

In Bombay, the work is proceeding on the lines described in the previous report, *viz.*, (1) introduction of Broach and Cambodia into Southern parts, (2) production by isolation and selection within the indigenous varieties of high ginning strains in Gujerat and (3) the spread of *roseum* cotton in Khandesh. It is naturally being hampered by the continuance of the European war and last year's unfavourable season will add to the difficulties in making further progress in some cases. The Department continued to give help in marketing the produce which, as stated in the last year's report, is one of the first essentials in introducing any improved strain of cotton. The scheme, however, of marketing improved cotton by co-operation has been tried at Surat and has worked well. It is possible that with the advance of the co-operative movement this work could be handed over to private bodies. The scheme consists in the formation of a committee representative of the cultivators of a group of villages with the Divisional Inspector of Agriculture as chairman. The committee watches

the fluctuations in the market and selects a favourable occasion for sale. All the cotton is in the meantime delivered at a central ginnery and is allowed to accumulate till the date of sale. Last year about 400 acres were grown under selected strains in Surat and the net result of sale by the above scheme was a gain of $7\frac{1}{2}$ per cent. over current market rates.

The Broach and Cambodia cottons in the Southern Division have not yet established themselves well as both the quantity and the quality vary according to vicissitudes of season. Last year unusual rains spoiled Broach cotton to a large extent. The staple of Cambodia cotton is also deteriorating. To meet all these conditions, experimental work in selection and cultural methods has been started. About 2,500 acres under Broach and 600 acres under Cambodia were grown from the seed supplied by the Department, which also made arrangements for the sale of the produce.

In Sind, the cultivation of the American cotton is increasing year by year. A seed farm of 200 acres has been established to facilitate this work. In 1914, 550 bales of lint (400 lb. each) of this cotton were exported and seed for 5,000 acres has been distributed for the current season.

In the United Provinces, the Economic Botanist continued his work on the different types of cotton with a view to the evolution of the desired plant.

In the Cawnpur, Farrukhabad, Mainpuriand Etawah districts the introduction of Cawnpur-American cotton is being continued. 2,200 acres were sown with this seed and arrangements made with the Elgin Mills to take over the crop. Some 450 bales of lint were made over to the mills. Much of the cotton however did not pass through the Department's hands but was sold in the open market.

In the Western and parts of Central districts the demand for Aligarh white flowered cotton was small as compared with previous years. Seed for about 10,000 acres was bought from the farms and in addition a large area was sown from cultivators' own seed. In some places co-operative credit societies have started definite seed schemes for the supply of seed of this variety.

In the Punjab, the progress at present consists in the introduction of American cotton in the Canal Colonies, but selection

work with indigenous varieties has also begun and an early decision as to the best variety to be pushed may be hoped for. In 1914, over 2,000 acres of 4 F. American cotton was grown from seed supplied in the Chenab Colony and about 400 acres in the Jhelum Colony, the produce fetching a premium of between Rs. 2-5-0 and Rs. 2-8-0 per maund over country cotton. The area under this cotton is increasing and it is estimated that about 7,500 acres are being grown this year. The proposal to grant a lease of land on the Lower Bari Doab Canal to the International Federation of Master Cotton Spinners' and Manufacturers' Association for a model plantation of American cotton has not materialised as the war has thrown considerable difficulties in the way of carrying out the scheme.

A preliminary examination of Burma cotton has resulted in the isolation of types which show a wide range of variation in ginning percentage (25—40). Suitable strains will be selected and grown on a large scale.

During his last visit to India, Mr. Arno Smith Pearse, Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Association, remarked as a result of a tour in Burma that the cotton crop there contains a proportion of fairly long staple cotton which, if picked and marketed separately, would command a high price. This was put to test last year and the results confirmed the verdict. There are however no data as to the proportion which such crop bears to the total production and enquiries will be made on this point.

(*c*) **Wheat.** The special feature of the results of the wheat improvement work during the year is the progress Pusa 12 has made in the United Provinces. The past season was not a very favourable one for wheat throughout India and in the United Provinces the general wheat crop was attacked by rust and the yield was seriously diminished. Under these adverse conditions Pusa 12 again stood out markedly and gave a good yield even in the worst affected districts. Thus it has stood the test of the past two adverse seasons, and this fact has brought on an instant appreciation on the part of the cultivators of its improved quality. On the Shahjehanpur Sugar Station the outturn was over 30 maunds per acre. Very good results were also obtained on

the private farms in Oudh. The question now is how to organize seed distribution so as to replace the country wheat systematically over large areas. There was keen demand for the seed last season, but the supply was not sufficient to meet it. It has now been arranged to grow it on a number of private farms for seed purposes and some of the co-operative societies will purchase seed from growers. A consignment of surplus stock of this wheat was shipped to England in June 1915 in order to bring the product to the notice of the Home Millers and it is hoped in 1916 to send larger quantities and to organize the work in such a manner that some of the local markets will be able to supply it to the shippers. In the Punjab, Pusa 12 is getting so popular that an urgent demand for leaflets giving information is springing up.

Pusa wheats are also gaining favour in Bihar and about 230 maunds of different varieties were distributed last year.

In the Punjab and the Central Provinces, improved varieties of wheat selected by the Department as well as Pusa strains are being tried and pushed in places where they have done best. In the latter Province the distribution work has been organized on the lines of the work on cotton seed distribution in Berar.

Experimental work is in progress throughout wheat growing provinces in selection and cultural and other methods relating to wheat improvement; while at Pusa progress is being made in further improving the wheats in the directions of increased rust-resistance, better standing power and higher yield.

(*d*) **Tobacco.** A large quantity of seed of the cigarette tobacco, Type 28, was distributed from Pusa in response to an increasing demand. The seed was cleaned and separated into two grades by a special machine before issue, thus ensuring that only heavy and well filled seeds were supplied. During the year the practical results relating to the curing and cultivation of tobacco were published in a Bulletin.

In Bengal, a survey is being made in the tobacco belt of the Rangpore District with a view to finding out varieties which may suit Burma buyers. There is practically no demand for high grade cigarette tobacco as the manufacturers confine themselves to buying country tobacco.

In Burma, pending the establishment of a special tobacco station, some preliminary experiments have been undertaken at Hmawbi.

(*e*) **Sugarcane.** An increasing amount of attention is being paid to the improvement of sugarcane in India. The past year has been of special interest for work in this crop in that the high prices ruling for sugar and jaggery gave a stimulus to its cultivation, thus enabling definite advances to be made in several places.

Progress in research work continued to be made by Dr. Barber at the cane-breeding station at Coimbatore and by Messrs. Woodhouse and Somers Taylor in Bihar. A large number of new seedlings have been raised on the cane-breeding station and studied in detail. Some of them are being tested outside the station and also in Northern India. The thin, hardy canes of the Punjab have been studied and their systematic description has been published in the *Memoirs of the Department of Agriculture*, Botanical Series, volume VII, no. 1. In Bihar, the canes have been classified and described by Mr. Woodhouse and his colleagues in Memoir no. 2, volume VII, of the Botanical Series. A feature of this work is the broad connection which has been established between the botanical and chemical characters of many of the varieties.

From the point of view of the immediate practical results in Northern India, the work at the new sugar station at Shahjehanpur is of the greatest promise. There, Mr. Clarke has obtained best results with a medium-sized cane known as Java 33 which is being tried in different parts of the Province, and appears to possess the essential qualities for general cultivation. In the submontane tract of the Gangetic alluvium, this cane gives a satisfactory yield in the field and has a high juice purity. Its sucrose content is well above that of the local canes. One thousand maunds of cuttings were distributed to the cultivators and the crop is reported to be doing well. A much larger quantity of cuttings will be available this year and the results will be of great interest.

The improvement of cane crop in these Provinces is, as the Director says, likely to be a slow matter. " Mere substitution of

one variety for another will not effect it. The natural tendency has been to reduce expenses to a minimum rather than to put more money into the crop to improve the outturn and quality. The best hope of raising the standard of cultivation lies in co-operation between growers and owners of modern sugar factories who are concerned in securing a steady supply of good quality cane."

In the rest of the Provinces, several local and foreign varieties are being tested and such as are found to be superior are introduced into the localities suited for their cultivation. Thus, in Assam, some of the improved varieties are much appreciated and are gaining in popularity, some 70,000 sets having been distributed during the year. The experiments at Kamrup to demonstrate the possibilities of growing sugarcane on a commercial scale by steam tackle were begun during the year, but difficulties in obtaining labour and the late arrival of the tackle delayed the planting of the cane and heavy rain caused troubles owing to water-logging. This brought out the importance of efficient drainage for the well-being of the sugarcane crop in this tract and a drain trenching implement to be worked by the steam tackle has been ordered with a view to carrying out drainage work more satisfactorily. In Madras, Red Mauritius is now established in 150 villages in South Canara, the total area being 424 acres as against 194 acres last year, while in Vizagapattam District 45,000 sets of a variety B 1,529 found suitable to the local conditions were distributed. The use of oilcakes for manuring is also spreading in this District and some 16,000 lb. were sold by the Department. In the Mysore State, prospects of introducing improved varieties are very bright and the Department is already doing useful work to this end. Some years ago an elephant cane was introduced on a small scale into a *taluq* and during the year it is reported to have given a yield of 50 tons of cane to the acre with a money value for the jaggery of Rs. 800. This is of course an unprecedented yield, and the cane itself is not a particularly rich one, but it shows to what extent improvement in the cane cultivation in India can be effected. In Bombay, important results have been obtained on the Manjri sugarcane farm in cultural methods which have been found not only to give crops of 40

tons per acre on an ordinary soil, but also to effect large economies of water and manure and in the cost of cultivation and seed as compared with local practices. These improvements are being widely made known and are spreading amongst the cane growers. In order to improve the crude methods of growing sugarcane in the area commanded by irrigation in the Deccan, the Bombay Government has sanctioned a new post of sugarcane expert which has been filled up by Mr. G. N. Sahasrabudhe who was deputed to the West Indies some years ago to study the subject. Instructive results have been obtained on the Sindewahi Farm in the Chanda District of the Central Provinces by extending the planting season but shortage of water in the tank caused restrictions in the extension of area. Promising results were obtained from experiments in growing sugarcane in the Mon canal area in Burma, a yield of 30 tons of cane per acre having been obtained in some cases.

In the North-West Frontier Province experiments were carried out by Mr. Leather, the Imperial Agricultural Chemist, in the clamping of sugarcane on a large scale and the results leave no doubt that sugarcane can be carefully preserved in clamps until the end of March at Peshawar without suffering any serious loss. This is important from the point of view of a sugar factory as it will enable the factory to prolong its season.

Side by side with improvements in varieties and cultural methods, the mechanical problems in connection with the manufacture of sugar or *gur* are also being investigated. Mr. Hulme, the Sugar Engineer, brought out from home a plant designed for use by small capitalists for turning out either *gur* or sugar. It was worked last season for sugar and the produce was of a very fair quality. Some defects however developed in the plant which have been remedied. Its working was very economical as no fuel in addition to the megass was required.

Mr. Clarke also is making experiments with the aid of Mr. Vick, the Agricultural Engineer, to find out a suitable small power mill capable of being worked by the oil engines ordinarily employed by small zemindars and enterprising cultivators for pumping purposes. None of the designs tried so far have given promise of superiority over bullock mills except in point of speed,

Similar work is in progress in Bombay where various types of bullock-driven mills and power crushers suitable for large estates as well as for areas of 10 to 20 acres have been tried. In other Provinces, notably in Assam, Central Provinces, Madras and Mysore material advance has been made in introducing iron mills in place of old wooden ones.

Simultaneously with the improvement in the manner of crushing, methods of manufacturing *gur* are also being improved. Furnaces suitable for different conditions have been designed and their merits are being demonstrated on a large scale especially in Mysore, Madras and Bombay. In addition to the saving of time, the improved furnaces turn out better quality *gur* in an economical manner.

The present season was a very favourable one for sugar factories, on account of the high prices of sugar due to the war. There was an increase in area under sugarcane in Bihar factories, some 15,000 bighas being planted with this crop in factories belonging to the Bihar Planters' Association only.

Other sources of sugar. (*a*) *Date Palm.* Mr. Annett has continued his investigations in connection with the manufacture of *gur* from date palm. A small apparatus such as is used in America for the production of maple sugar has been ordered for trial.

(*b*) *Beet.* Further experiments at Peshawar have confirmed the results previously obtained that heavy weight per acre of high quality sugar beets can be produced in the Peshawar Valley from 15th March to 15th June. It is, however, to be ascertained whether cultivators in the valley would grow the crop for a factory and arrangements are being made in this direction.

(*f*) **Oilseeds.** *Groundnut.* This crop is now fully established in parts (United Provinces, Central Provinces and Burma) where it was not previously grown, while in Madras and Bombay superior varieties introduced some years ago are gaining favour. There was however some decrease in area under it especially in Bombay and Madras due to unfavourable season at the sowing time, but in Burma there was an increase of 8 per cent. over last year. As mentioned in last year's report various advantages

(such as value of outturn, supply of good fodder and the manurial fertilizing effect) favour the cultivation of this crop. It is therefore readily taken up once it is proved that it is suitable to a particular area. It was tried in Berar during the year under report in various districts and the results are so promising that it might prove a suitable rotation crop to cotton growers.

Cocoanut. The chief work on this crop was as in the previous year confined to investigating and controlling fungus diseases in Malabar and Travancore but a distinct advance has now been made in the matter of taking some definite action for the improvement of the cocoanut industry in Malabar, where the finest quality *Copra* is produced in the world. A very large trade in the export of *copras* for the manufacture of vegetable butter has recently sprung up and the demand has largely exceeded the supply. Both on this account and on account of the possibilities which exist in India for substituting cocoanut butter for *ghee*, it is necessary to encourage increased production. As the industry is capable of extension and offers great possibilities for improvement by manuring, control of disease, co-operation and an easing of the restrictions due to a bad land tenure system, the starting of 5 experimental stations for dealing with some of these points is under consideration and they are soon to be put under way.

In the Travancore State different varieties are being tested at a special cocoanut farm with a view to study their respective characteristics. The plantation will bear fruit in another two or three years. In the meantime experiments with manuring have given very promising results and the cocoanut growers are now realizing the value of proper cultivation and manuring. To help this spirit of awakening and interest a number of depôts have been opened for the sale of manures.

Other Oilseeds. Investigations have been in progress in the Botanical Section at Pusa with some important Indian oilseeds such as safflower, *rai* and linseed and the results obtained are of great importance. They point to the necessity of selection in such crops as these where some crossing takes place and where the range of form is very great. Form separation conducted on a broad basis is likely to lead to the isolation of a desired type

which could then be multiplied and issued to cultivators. Work on 'Sesamum,' which now covers a million acres in Burma has been commenced at the Tatkon Station in that province. The fine types are being collected with a view to comparison for earliness, yield and oil content.

(*g*) **Tea, Coffee and Rubber.** The year was a prosperous one for the tea industry. The war has had a beneficial effect on the trade and the demand in the consuming markets having been increased prices kept level. The area showed an increase of 2 per cent. over that in 1913, the new extensions amounting to 16,000 acres while the net increase in production amounted to 6 million pounds or 2 per cent. almost entirely in black tea. The total exports by sea improved by 11 million lb. or nearly 4 per cent.

The Scientific Department of the Indian Tea Association continued to receive a subsidy of Rs. 15,000 from the Government of India towards research work. The work as in the previous year has been mainly in connection with soils and manuring, mosquito blight and root disease. The expert staff which consists of a Chief Scientific Officer, Assistant Scientific Officer, Entomologist and Mycologist was increased by the appointment of a Second Assistant Scientific Officer.

Important results have been obtained in manurial experiments on tea seedlings. Although they require confirmation, yet they have been indicative of the importance of applying manurial ingredients in forms and proportions suitable to the particular type of soil and plant which is being treated. The effect of lime in improving the growth of seedlings was demonstrated.

Several important steps towards the solution of the problem of correct pruning have recently been demonstrated and put in practice. A bulletin on the subject was published during the year. Another bulletin on the spraying of tea was also published to give planters a definite knowledge of spraying in order to keep under control the pests and blights which cause such an immense loss every year.

As usual a great deal of the time of the Scientific Officers continued to be spent in touring and advising planters on various matters connected with improvement of the crop.

The work of Scientific Department of the United Planters Association of Southern India could not make any material progress owing to the difficulties in the way of conducting experiments on scientific lines for want of an adequate staff. A scheme to hand over the department to the Madras Government to be run as a separate Government Department on an elaborate scale is under consideration.

Various manurial experiments were continued on coffee and rubber estates under the advice of the planting expert and several estates have taken up systematic manuring. Trials were made with a new coffee drier and give promise of being a great success. A scheme has been approved by the Madras Government for protecting the bees (*Apis dorsata*) in areas in the vicinity of coffee estates, as they have been found to play a useful part in the pollination of coffee. The various fungoid diseases and insect pests of coffee which yearly take a heavy toll of the crop are being tackled in co-operation with Dr. Coleman, the Director of Agriculture, Mysore, who has taken up their systematic study and is doing an important work in controlling them by vigorous and organized efforts in Mysore.

(*h*) **Indigo.** At Pusa considerable progress was made in the indigo investigations which enabled definite recommendations to be placed before the planting community. Indigo wilt was proved to result from a water-logged condition of the soil, while surface cultivation in the hot weather combined with drainage in the monsoon was the secret of the successful growth of both Java and Sumatra indigo. A method of growing seed of Java indigo has also been evolved and is rapidly being taken up all over Bihar. Formerly the old indigo crop was kept over the cold weather and seed was collected from these plants and, in many cases, owing to weakness from wilt only a small quantity of pure seed was produced, while large areas were set aside for seed which became very foul with weeds. The new method does away with these conditions and leads to the certain production of well-grown seed from a small area which can easily be kept clean. A new variety of wheat, Pusa 4, has been introduced for growing as a better cover crop with indigo on the high lands. The question of increasing the efficiency of *seeth* as a manure is also

under consideration and evidence has been obtained that part of its value in tobacco growing is in aerating the soil and providing soil organisms and the roots of tobacco with an adequate supply of air, which points to the fact that its efficiency can be greatly increased by adding a proportion of broken tiles to the soil. The progress which has already been made in the indigo investigations indicates that the prospects of resuscitating the industry are very favourable. The competition of synthetic indigo having been for the time removed, a period of high prices has set in which will afford an opportunity of re-establishing confidence and putting those estates into order which are still growing indigo, prior to the introduction of new and improved methods of cultivation and manufacture.

At the instance of the Government of India a conference was held at Delhi in February 1915, at which representative members of the planting community met representatives of Government. An interchange of views took place, the progress made in the investigations by Mr. Howard, the Imperial Economic Botanist, was detailed and the Government of India decided to supplement his work by the employment of a Chemist to continue the investigation of the chemical problems in manufacture.

The removal of the competition of the synthetic product for the time being has given considerable stimulus to the growth of indigo in provinces where the industry was of importance in former times. Larger areas were put under the crop in Bihar, the United Provinces and Madras although the difficulty of obtaining good seed was very great and prevented much larger extension. In Madras the Department of Agriculture made timely arrangement to stock good indigo seed for distribution as it seemed likely that owing to the war indigo cultivation would bring in great profits. About 24,000 lb. of seed was readily disposed of in villages where old vats still existed. Later on, as was expected, the price of seed rose very high, there being besides a great deal of adulteration.

(*i*) **Fruit.** The subject of fruit culture is receiving an increasing amount of attention at the hands of the Botanists in some provinces, while the work at Quetta has developed considerably.

At Quetta work on fruit packing was continued and the distribution already made of a large number of boxes should help to raise the present low standard of fruit packing in India. In 1913, a beginning was made with the supply of fruit trees to the public and during the past years between 4,000 and 5,000 trees were sold. The development of the fruit industry in Baluchistan seems to be dependent on the propagation of suitable varieties on suitable stocks and the experiments in this direction are already yielding most interesting results.

In provinces, the main lines of work consist in surveying suitable localities for fruit growing, stock experiments and the testing of varieties. In Bombay, a study of the varieties of mango has been made and ripe fruits have been obtained from artificial crossing. Mango canning has also proved fairly successful. Manurial and cultural methods for fruit plantations are under trial at the Ganeshkhind Botanical Garden and the testing of citrus stocks is in progress. The members of the Garden staff have specialized themselves in the culture of different fruits and their advice is much appreciated by the fruit growers. This is evident from the fact that in order to meet the demands of the growers from various parts, gardens have been organized on some of the agricultural stations and the members of the staff are being trained in horticulture. In the Central Provinces, work is in progress in the cultural methods for oranges, while in the Lushai Hills in Assam demonstrations in fruit culture are pushed on, the principal kinds of fruits introduced being orange and pineapples.

At the Saharanpore Gardens, an additional area was planted with fruit trees and various experiments are in progress. The garden is now the most complete of its kind in India with regard to fruit trees. A new catalogue of fruit trees for sale was published giving fuller description of the varieties available and many hints on cultivation.

The olive cultivation in the salt range in the Punjab has made steady progress, despite the financial restrictions which hinder further advance for the present. A scheme for providing a basis for furthering the experiments is now under consideration of the Local Government.

(*j*) **Fibre Crops.** Amongst the fibre crops of India jute stands first in importance after cotton in acreage as well as in the value of total outturn. But if we compare the relative value of outturn per acre, we find it exceeds that of all crops including sugar. The area under the crop is about 3,000,000 acres and most of it is confined to Bengal, a small area of about 400,000 being grown in Bihar and Assam. The crop therefore is of great importance to Bengal and a special appointment of Fibre Expert exists there to deal with problems connected with jute improvement. Of late years, however, there has been a great demand for jute fibre and the supply has fallen short of the requirements of the trade, which has consequently been pressing for increasing the output either by extension in area or by improved methods. In order therefore to examine what has already been done and to suggest measures for improvement a conference of officials of the Departments of Agriculture in Bengal, Bihar and Orissa and Assam was held at Calcutta in August 1915, to which representatives of the jute trade were also invited. A full account of the discussions has been published. The conference was of opinion that there is room for improvement in the existing system of cultivation and production of the jute crop but that the work is handicapped for want of sufficient trained experts. Some work has already been done in evolving superior seed and finding out better methods of cultivation but in order to put them in practice a strong and efficient staff is required.

Next in importance among fibre crops are Sann hemp (*Crotalaria juncea*) and Deccan hemp (*Hibiscus cannabinus*). Investigations were in progress for some years past with the latter crop in the Botanical Section of the Pusa Institute and they have produced important results during the year under report. After selecting a suitable type, a system of removing heterozygotes during the seedling stage was adopted in order to minimize the effect of natural crossing. This proved successful and when a supply of pure seed was obtained, a sample of fibre carefully retted and cleaned in clear water was sent for valuation. It was valued at £18 per ton as against £8 for ordinarily cleaned fibre. The type is being grown on some estates in Bihar with a

view to discovering whether it can be grown on a commercial scale.

2.—Special Subjects.

(*a*) **Agricultural Education.** The year 1914-15 has been of importance in the history of agricultural education in that the policy laid down previously was changed according to the recommendations of the Board of Agriculture, 1913. Generally speaking the change consists in having two courses, *viz.*, one practical and the other of a more advanced type suitable for those capable of following it, the first being intended for those who either want to return to their land or to secure posts of agricultural assistants, while the second is for those who aspire to greater things on the scientific side or are candidates for posts in the higher subordinate service. The syllabus of studies has been arranged according to the local conditions prevalent in each province, and the change has been reported generally to have brought about very good results in increasing the popularity of the colleges.

At the Coimbatore College 42 students were admitted for the first two years' course which will be devoted mainly to general agriculture and its allied occupations, *e.g.*, the dairy, cattle feeding and rearing, care of implements, etc., the lectures in both scientific and agricultural subjects being fitted in with the general scheme of practical work. Those who wish to prosecute their studies further will, if thought fit, be taken for an additional eighteen months' course devoted mainly to the sciences in their application to agriculture. There is a Students' Union at the College which is doing excellent work in keeping old boys together as members of a corporate body, and all students who leave the College become members of this Union. It issues a magazine which has just been converted from a quarterly into a monthly—a proof of its popularity.

A change on similar lines has been effected in the curriculum of the Nagpur Agricultural College from 1st July, 1915. Ordinarily only 'matriculates' will be admitted to the first two years' course and those who pass in the first division will be eligible, should they desire, to take a higher course of science for eighteen

months and will be awarded the degree of L.Ag. after passing. Under the old system 30 students were admitted in the first year in July 1914.

In the Lyallpur College, Punjab, the old three years' syllabus was brought to a close in April 1915 and a new course of four years divided into two parts was started. This change combined with the increase in the pay of assistants employed in the Department and lowering of the cost of education have favourably influenced recruiting. There were 23 students in the first year class by October 1914. The second part of the course which includes tuition in sciences appertaining to agriculture will not come into operation until 1916-17. There is also a six months' vernacular class intended for the sons of zemindars and 16 students attended this class of instruction.

The new courses started at the Agricultural College, Cawnpore, are of a different nature from those above mentioned. The first is a vernacular course of two years and is quite distinct from the other which is a higher diploma course of four years. The qualifications required for each are different and it is not intended that one should form a stepping stone to the other. In the two years' course there will be no instruction in elementary sciences, only practical knowledge of agriculture being imparted. It is intended for sons of cultivators or landlords or for those who wish to enter the lower subordinate ranks of the agricultural service. The four year or diploma course will include a wider study of agriculture and its allied sciences, and the higher ranks of the agricultural service will be recruited from those obtaining this diploma. So far, both the courses have filled satisfactorily.

No revision of courses has yet taken place in the Sabour Agricultural College in Bihar, but a scheme to bring it into line with other Colleges is being worked out for submission to Government. Under the old system 14 students were admitted in the first year class, but out of these only one belonged to the province of Bihar and Orissa. In the final examination 6 out of 7 students obtained the diploma.

The Poona Agricultural College continued to maintain its popularity and the inauguration of a short course has increased the number of students to 124. There is a good demand for this

course and the development in this line is expected to yield beneficial results. The development of vernacular agricultural schools has also advanced further. The Loni school near Poona has now passed the experimental stage and is regarded as an established success. 43 students are receiving education in this school while those who have passed are said to be doing useful work on their own lands. Similar schools at Devi Hosur (Dharwar) and in Sind are becoming popular, while two new schools are projected, one in East Khandesh and the other in Thana, assisted by endowments from the people of the districts.

Among Native States, Mysore has an agricultural school and is reported to be doing useful work in turning out men who either want to do farming or are required for service in the State. There is a demand in this State for men to act as overseers or managers on large estates and there are, therefore, good prospects of the future usefulness of the school. 14 students passed the diploma examination during the year.

Training in postgraduate courses continued to be given at Pusa. There were 2 students in Botanical, 1 in Mycological, 1 in Bacteriological and 2 in Entomological Sections.

Besides the regular training in these schools and colleges, short courses in vernacular were given at Pusa and also in some provinces in special subjects, such as sericulture, lac culture, jaggery making, cultivation of special crops and the like. The attendance at these courses has been satisfactory and they serve a very useful purpose in the extension of improved methods.

(*b*) **Demonstration of Improved Methods and Distribution of Seeds, Implements and Manures.** One of the first essentials in agriculture is seed and this offers perhaps the greatest scope for general improvement in the industry. Once an improvement in any variety is effected, the next step is to spread it among the general population. In Western Countries, the former is done by Government Departments, while the latter is taken up by the private agencies. In India, however, the conditions are different. The Departments have to do both jobs and the time and energy of the expert officers are and will be, for some years to come, devoted to the latter task to the detriment of their experimental work in many cases. It is impossible to raise on

Government Farms all the seed required and to cope with this, private agencies are being organized such as co-operative unions, private farms, etc., the Department being responsible for the quality of the work. It is in this line that gradual development is taking place in more advanced provinces. Besides doing the work of raising seeds, these organisations are also being utilized as a means of spreading improvements.

In the Bombay Presidency, district work continued to expand and a distinct advance was made in some parts in establishing implement depôts, popularizing implements, distributing seed, inducing cultivators to steep *Jowari* seed in copper sulphate solution, introducing the use of silos, and helping cultivators to adopt improved methods of cultivation. Some new agricultural associations came into existence while others are reported to have done useful work in carrying out demonstrations and in organizing cultivators' meetings. The connection with co-operative societies has also extended in a number of ways.

The work of popularizing improved implements such as ploughs, etc., has considerably extended and there is a great demand for such implements on hire. Many agricultural associations and also individuals now keep implements on such terms, one man having a stock of over 100 English ploughs for the purpose.

Demonstrations on Government farms to a large number of cultivators now form part of a regular programme of the Department's work, while regular classes are also held periodically to give instruction in some definite improvement, such as sugarcane cultivation and *gur* manufacture. The last of the sugarcane class on the Manjri Farm was attended by 50 persons and in addition, trained men were sent throughout the Presidency to build improved furnaces and to give instruction in the manufacture of *gur*.

Considerable expansion has taken place in the general development of district work in Madras, especially in spreading the growth of selected strains of cotton and economical methods of paddy cultivation. Areas of farms used for cotton seed production have increased and a system of joint sale of produce by a group

of villages direct to firms, has been found to work well. Improvements in paddy cultivation were demonstrated on a number of demonstration plots and endeavours were made to get other ryots to reduce the extravagant seed rate they employ at present. The cultivation of green manure crops for paddy has developed, over 146,000 lb. of seed having been sold by the departmental agency alone. The use of fish manure received a check owing to failure of the catches on the West Coast, but the use of oilcake for manuring sugarcane has increased in some districts.

Among implements a demand for Monsoon ploughs is growing up while in Tinnevelly the use of drill and harrow made a marked advance. The use of iron crushing mills for sugarcane continued to spread and a start was made in introducing improved furnaces for *gur* manufacture. The co-operation of villagers in combating palm disease was secured to a greater degree which rendered a detailed search for infection possible in many villages.

In the United Provinces the activities were mostly confined to the provision of seed by establishing closer relations with co-operative societies, some of which took an active part in the distribution of Pusa 12 wheat in the Central Circle. In the Eastern Circle, a number of private seed farms have been opened by well-to-do zemindars, and the results were so satisfactory last year that the farms have been considerably extended. They not only serve a very good purpose in the multiplication of seed, but have proved a useful means of bringing the merits of approved seed and methods to the notice of a large number of cultivators.

A number of demonstrations were given on the farms owned either by Government or Agricultural Associations or on cultivator's plots. Arrangements have been made to store implements at all farms and at some of the co-operative societies' depôts. Ploughs continue to be most in demand. 17 agricultural exhibitions were held in different parts of the province and the practice has been introduced of awarding implements instead of money prizes at these exhibitions. The demand for pumping installations increased considerably beyond the scope of the skilled drivers available and arrangements have been made to train a larger number of such men.

The main features of the demonstration work in the Central Provinces continue to be the spread of—

(*a*) transplantation of rice in Chhattisgarh,

(*b*) *Roseum* cotton in Berar, and

(*c*) improved wheat in Northern districts.

Considerable progress was made in all of these, but perhaps the most important advance was in the method of bringing the results of the Department's work more extensively to the notice of cultivators in villages. Agricultural Associations have been formed in each *taluq* in Berar in order that members living in a small area may meet more frequently than has been possible for those of district associations and take a keener interest in agricultural improvement. One of the conditions of membership is that every member must do something to improve his own agriculture by employing the methods advocated by the Department. The success of the scheme will mostly depend upon the interest displayed by the Tahsildar (Revenue Officer) who is the chairman of the Association. Much useful work has, however, already been done by some, while all have agreed to stock agricultural implements and manures of proved merit.

In the Northern districts of this province private Unions have been formed to run demonstration plots. The Unions maintain their own ploughmen and supply the necessary stock to work the plots. The Department supplies a trained *kamdar* to supervise the work of each and to carry out demonstrations approved by the Department at the desire of the members.

Agricultural implements to the value of Rs. 20,000 were sold in various circles and are being stocked by private agencies.

In the Punjab, district work was confined to the Colony areas and a few other districts where an efficient supervision was possible. Agricultural associations helped by district Agricultural Assistants continued to be the principal means of spreading improvements. A large number of demonstrations (in the use of improved implements) were given at fairs and on zemindars' land and touring parties were sent, as a new departure, to many villages to show the uses of improved ploughs. This, coupled with the practice of lending implements to selected zemindars, has resulted in the sale of a larger number of Meston ploughs

than in the previous year, the number being 660 as against the average of 132 during each of the previous five years. Besides small implements, reapers and threshers are steadily increasing in popularity in Canal irrigated tracts, partly owing to departmental efforts and partly owing to high prices of labour.

Another line of activity in this province consisted in the growth and distribution of improved wheat and American cotton seed. The area under these has increased, being now 8,000 acres under the former and 2,500 acres under the latter. The system followed in the growth of these crops was the same as mentioned in last year's report, *viz.*, through the agency of selected zemindars. It was not possible to take advantage of the co-operative movement owing to exceptional circumstances of the year.

From the rest of the provinces, there is not much to report over what was mentioned last year. With recent appointments of more expert staff in some of them and with the advance of experimental work in others, a considerable expansion is to be expected. An increased number of demonstrations on demonstration farms as well as on cultivators' plots were, however, given either through the agency of agricultural associations, honorary associates or by the departmental staff in order to bring some definite improvement to the notice of a larger number of cultivators and the result has been in most cases satisfactory.

Amongst Native States who maintain Agricultural Departments, Mysore has an adequate staff of assistants both for experimental and district work and consequently marked progress is being made in various lines. As a result of ploughing demonstrations in a large number of villages, the sale of iron ploughs increased from 446 in 1913-14 to 613 last year. Similarly, demonstrations in jaggery boiling, economic transplantation of paddy and the use of green manure and oilcakes have resulted in an increased adoption of the improvements advocated. Large quantities of groundnut, sugarcane, *ragi* and paddy seed were supplied from the two State Farms.

(*c*) **Agricultural Engineering.** The activities of this important branch of agriculture are at present mostly confined to affording facilities for increased irrigation by well boring and spreading the use of power pumping plants, a work which promises

to be of very great possibilities. In Bombay and the United Provinces it has already produced results of great benefit to cultivators and offers chances of great expansion.

In Bombay the erection of pumping plants has made further progress. By effecting improvements in the plants which reduce the chances of a breakdown and by giving advice and assistance in their erection a distinct advance has been made in the matter of lifting water by this means. Several large pumping plants have been erected with the intention of selling water. The success of such enterprise will however largely depend upon the enterpriser's ability to arrange for the skilful use of the water by the purchasers. Boring of wells continues to make progress in Gujerat, while its extension to Deccan and Southern Maratha country has given some useful results.

In the United Provinces tube wells have so far proved a success wherever tried and have proved the suitability of many parts in the province to this sort of undertaking. A number of orders were received from Court of Wards and other Estates but could not be completed owing to difficulties in procuring plant from Europe. A power boring plant has been ordered which will considerably facilitate the sinking of these wells. In Bulandshahr and adjoining districts the use of pumping plants is being extended as the conditions here are favourable for their introduction owing to there being a number of wells whose water supply can be extensively increased at a small cost by boring. A local company has been formed here for bringing out oil engines and installing them, and a school for training drivers has been started. A promising project for raising water from a small river for irrigation on co-operative principles has been undertaken.

The experience so far gained in boring work in this province has enabled the Department to define the areas where this work is likely to be successful and endeavours will in future be made accordingly. During the past year 1,185 borings were made in the existing wells.

In the Punjab, an Agricultural Engineer has recently been appointed and he has made a study of various sub-soil conditions and the treatment required to meet them for successful borings. During the year there has been a keen demand for boring but

owing to labour and other difficulties, which are being remedied, delay occurred in meeting them. 237 borings were undertaken, out of which 141 were successful. The rest either were not completed or required different treatment. The Agricultural Engineer has also studied the possibilities for introduction of tube wells and for undertaking larger irrigation schemes by impounding reservoirs.

In Bihar and Orissa, boring work could not be extended owing to the absence of a whole-time Agricultural Engineer. In the Patna Division where the operations have already proved successful the work was transferred to the District Boards and the energies of the Department were confined to other Divisions where 26 borings were made, out of which 22 were successful.

(*d*) **Dry-Farming.** The experiments in water saving at Quetta by Mr. Howard were completed during the year and the results are of more than local interest. It has been proved that very good crops of wheat can be obtained by a single irrigation instead of the common practice of giving six or seven. This single irrigation is to be applied to the land in September after which it should be cultivated and then sown. After each fall of winter rain or snow, the field sown is harrowed which helps the soil not only to retain moisture but also to admit an ample supply of air for the roots. Trials on these lines gave an outturn of $16\frac{3}{4}$ maunds of wheat per acre as compared to $13\frac{1}{2}$ maunds obtained with the local practice. These results are very important in that they show that a great saving in water can be effected which can then be utilized for extension of the area under irrigation.

The above results also apply to conditions in the Punjab where it has already been shown that a great waste of water occurs in the irrigation of wheat. A lease of about 20 acres has recently been taken in Attock district of this province for five years to be worked as a demonstration of dry-farming, especially of wheat.

In the United Provinces, the merits of hot weather ploughing in reducing the amount of water required for irrigating the wheat crop have already been proved. The practice is now adopted on the various farms of the Province and is also being introduced outside the farm areas.

In Bombay pending the study of soil physics which is considered to be of great importance to any attempts to find out methods of treatment suitable to particular soils, work has been continued in testing the principles of wider spacing and thorough interculture on *rabi* crops.

In Mysore, experiments conducted over a series of years have shown that the ploughing of dry land as soon after harvest as possible ensures a much better and more certain crop. This is already extensively practised in some districts and demonstrations were given in others where it was not known.

(*e*) **Sericulture.** This industry continued to receive attention in Bengal where it is of most importance. Further modifications are under consideration in the general scheme for supplying disease-free eggs to the whole province. Instead of Government establishing all the nurseries required for this purpose which will involve heavy expenditure, it has been thought more advisable to encourage professional rearers to rear most of the demand under Government supervision. For this purpose, a preliminary experiment is being made in a few cases to see whether healthy seed can be raised under Government supervision in the houses of selected professional rearers.

Promising results have been obtained in hybridizing experiments. Several multivoltine races have been obtained which give an increased yield of silk. These crosses were sent to Kurseong in order to preserve their quality during the months of May to September. It is proposed to substitute these improved cross races for indigenous ones during the months from October to April while during the rest of the year the rearers will be supplied with selected indigenous races. During the year under report an annual grant of Rs. 5,000 for five years was sanctioned by Government for Miss Cleghorn to continue her scientific research relating to silk rearing. She has obtained a multivoltine hybrid race which in its 36th generation has given cocoons superior to the indigenous race.

Thirteen boys passed from the Berhampur sericultural class and from the Rajshahi sericultural school, and the system of subsidizing such passed boys to enable them to raise model rearing houses was continued.

The rearing of silk worms at the Umlyangka Farm in Assam by the Roman Catholic Misson was continued. A report by Rai Bahadur B. C. Basu on his enquiry into the silk industry of this province was published and his recommendations for the improvement of the industry are under consideration of the Local Administration.

Attempts to establish sericulture as a cottage industry among poorer classes are being made in the Punjab, Madras, Travancore, Baroda and Mysore by the distribution of healthy seed and by educating the ryots in methods of rearing. In the first named province, European silk worms were successfully bred in the submontane tracts, and attempts to popularize the industry through the agency of the village schools gave promise of success.

Endeavours to establish a superior stable multivoltine hybrid race, which would not degenerate, were continued at Pusa. The univoltine mulberry silk worm eggs which were sent to Shillong and Muktesar for rearing in March gave satisfactory results. Eggs of both mulberry and eri silk were supplied to 315 applicants and arrangements were made for rearing eri-worms at Kumaun in April and May as it is difficult to procure a fresh stock of eggs for distribution in June and July. Two bulletins, one on silk reeling in Bengal and the other on mulberry silk experiments at Pusa, were published during the year.

(*f*) **Co-operation.** The chief object with which the co-operative movement was started by the Government of India was to deal with the 'status of stagnation' of the poorer classes and more especially of the agriculturists who constitute the bulk of the population. The most pressing problem of the agriculturist was how to carry on his existing business without gradually sinking into a condition of practical dependence on the money-lender. It was therefore the credit side of the co-operative movement which was first developed in India. Once the cultivator has been freed from his bondage to the money-lender for his current requirements he will naturally, with the education he has received in the principles of co-operation, take to other forms of co-operation, such as co-operative purchase, production and distribution. The main function for co-operative

societies in rural areas will, therefore, for some considerable time to come, be first the provision of credit facilities and then the supply of requisites for agriculture.

The success of these credit societies has been phenomenal. With a view to give legislative protection to co-operative societies organized for distribution and for purposes other than credit, and also to the Unions, Central Banks, etc., which had been formed to finance and control the original credit societies, the Government of India passed the Co-operative Societies Act of 1912 which regularized many practices which had been of doubtful validity before, allowed co-operative associations to exist for other purposes besides credit and made provision for further expansion under proper safeguards. This Act has given a great stimulus to the co-operative movement as will be seen from the fact that the number of societies in British India in 1914 was 14,881, the number of members 695,998 and the working capital Rs. 7,45,31,725. New types of societies for the sale of produce, cattle insurance, milk supply, manure purchase, etc., have sprung up. The movement was daily growing in volume and in view of the very large sums involved in the movement and the growing complexity in the arrangements for financial management in the stages above that of the individual society and the necessity for definite and certain principles of audit and inspection, the Government of India appointed a committee presided over by Sir Edward Maclagan to examine whether the movement, more especially in its higher stages and in its financial aspect, is progressing on sound lines. The report of that Committee has been published and while containing much useful information is full of practical suggestions.

Loans from Government form a steadily decreasing proportion of the total working capital of these societies. Of the purposes for which loans are required the most important is payment of old debts. The purchase of plough cattle stands next in importance, comparatively little being drawn for un-economic purposes such as purposes of ceremonial. The educative effect of the movement in the villages is considerable. The societies are coming more and more in touch with the Agricultural Departments and are utilized to an increasing degree by the latter for assisting

demonstrations, distributing seed, etc. In some cases they have begun to interest themselves in primary education, village sanitation and other matters of local interest.

The number of non-credit agricultural societies was 167 in 1914. The following table taken from the report of the Committee on Co-operation in India shows these societies classed under five heads :—

Agri. non-credit societies	Madras	Bombay	C.P.	U.P.	Burma	Coorg
Purchase or Purchase and Sale . .	..	11	...	...	...	...
Production . .	...	...	3	...	...	...
Production and Sale .	...	4	1	10	63	...
Insurance . .	...	...	...	1	59	9
Others . . .	6	...	...	...	...	...

Among agricultural non-credit societies, the outstanding types are those for the sale of produce and for cattle insurance. The former are at present chiefly found in Burma and combine with credit business the sale of paddy and groundnuts on behalf of their members direct to wholesale dealers at Rangoon. These societies by eliminating the middlemen enable the cultivators to realize some portion of the profits which previously went to these middlemen.

Where Co-operative Societies distribute selected seed of a particular variety in large quantities they should organize co-operative marketing so that adequate prices may be realized for the produce. If they wish to get into direct touch with large dealers they should be able to sell in large quantities and should offer one particular type properly graded or cleaned so that the buyer may know exactly what he is purchasing.

With regard to cattle insurance the Report of the Committee on Co-operation mentions that two different systems are being tried in India, one in Coorg and the other in Burma. Under the Coorg scheme the owner pays two-thirds of the value of the

animal insured into the society within four years by instalments of decreasing amounts and should the animal die before the payments are complete, the whole amount insured for is paid to the owner. If it survives the period the full amount of the premia paid but without interest becomes payable on death or invalidity. Under the Burma system only plough cattle and buffaloes between the ages of 4 and 12 are accepted for insurance. The amount of indemnity is two-thirds of the value of the animal as estimated by the local committee and this estimate is revised half-yearly. A premium is charged at the rate of 5 per cent. on the value of the animal. The premia are regarded not as a cumulative investment but as a payment for protection which extends only for the period covered by the current premium. The Committee on Co-operation in India are in favour of the Burma system as the premia charged under it are such that agriculturists can pay them in districts where cattle are not cheap. With suitable local modifications the scheme might be introduced as an experimental measure into selected parts of India where the Veterinary staff is adequate and the mortality from rinderpest is not high. It is true that actuarial data of the mortality of cattle in different districts are not yet available and that the premia charged will at first be empirical but as the Committee points out there seems no prospect of obtaining reliable figures except from the experience of insurance societies themselves. The Burma system provides that although the members of insurance societies should first be members of credit societies yet the finances of the two institutions are kept separate. The number of cattle insurance societies in Burma is now 63. With a view to spread risks over a considerable area and to prevent societies from suffering in cases of serious outbreaks of cattle disease in a particular locality, the scheme of a central reinsurance society has been adopted in Burma. This society has a guarantee from Government in the shape of interest-free loans up to Rs. 25,000 per year if required during the next five years.

Four cattle insurance societies have been registered as an experimental measure in the Mainpuri District of the United Provinces and a proposal has been submitted to the Government for special aid. It is hoped to organize a few more societies if

circumstances prove favourable so that the experiment may be conducted on a scale sufficient to furnish data for future development.

Societies for the insurance of agricultural crops against damage by hail have not yet been started in any part of India. The Committee advocates the formation of such societies and in view of the information existing in many provinces in connection with the remission of land revenue on account of damage done by hail they would in some respects be equipped with better actuarial data than societies for cattle insurance.

Burma reports yet another interesting form of co-operation which is being used in reducing the difficulties of colonization in areas lately brought under cultivation. The latest of these experiments is in the Kadonbaw Tract in the Hanthawaddy District where a forest reserve has been disafforested, and thrown open to cultivation. The tract covers about 23,000 acres. The area is leased to co-operative societies formed by groups of cultivators migrating to the area and not granted or leased to individuals. The tenure is a co-partnership tenancy without share capital, the funds for the initial breaking up of the land being taken from Government in the form of agricultural advances. The money is lent to societies at the ordinary rate of interest and they make advances to their members at higher rates. The difference in the rates of interest and the margin of rent over land revenue form the reserve fund which will amount to a substantial sum in the course of a few years. Thirteen settlements have already been formed each with its own society and loans have been granted sufficient to meet all reasonable needs of the colonists. When a society has broken up its allotment it will be in possession of a valuable security on which it will be able to borrow from the Mandalay Central Bank. The experiment is one of very great interest since it represents an attempt to combine the communal system of cultivation with principles of co-operation. As far as it has gone the experiment promises to be successful.

The increasing difficulty in procuring pure milk and other dairy products at reasonable rates has brought the question of co-operative dairying into prominence. It is sometimes assumed

in this country that what are needed to improve the city milk supply are individuals or companies who will take up the matter on a large scale with modern appliances. It would be well to make clear the difference between dairy farming concerns which aim at producing their own supply of milk which they propose to put on the market themselves and those dairying concerns which merely act as middlemen—buying milk in the country and putting it on the town markets by improved methods. The production of milk by dairy farming concerns situated in a town or in its vicinity is not likely to be done so cheaply as it can be by the small cultivator. The most promising source of milk supply for towns lies in the villages where cultivators keep their animals under natural and economical conditions. It is from such sources that an adequate supply of milk has been secured for the cities of other countries. The transport of milk is no doubt a difficult matter in hot countries but it has been overcome in the United States of America, and in this country for some time past pasteurised milk has been sent without difficulty from Poona to Bombay, a distance of 119 miles. It is only lack of organization that handicaps this branch of the industry.

The part which co-operative societies can undertake in developing the dairying business is clearly indicated in the following extract from the Report of the Committee appointed to consider measures for the improvement of the milk supply in large cities in the Bombay Presidency :—

> It is a matter of common knowledge that in other countries striking developments in the dairying business have been effected by the agency of co-operative societies, and we are of opinion that much progress may be made in this country by means of the same agency. In such matters as the financing of the milk producers, the joint purchase of feeding stuffs and the collection of small lots of milk there is no doubt that a co-operative society can be of much use. There is evidence that a co-operative society can undertake on a small scale the marketing of its own milk in a neighbouring town where the distance is not great; but doubts have been expressed whether a co-operative society is a suitable agency to undertake the more difficult task of handling milk for long transport or the work of retailing milk on a large scale, which demands (a special knowledge and experience together with

W. S.) a degree of care and activity not often found except where the retailer's personal interests are concerned. Co-operation cannot be regarded as a substitute for efficiency, and if efficiency is to be secured, the enterprise in each case must be large enough to afford the cost of capable management. The question how far co-operative societies should go in this matter, must, therefore, depend on the degree of efficiency which they can command and the question whether there are other agencies available to continue the work at the point at which they might feel disposed to leave it.

It should, however, be carefully borne in mind that an increase in the number of people or agencies who handle the milk in its transit from producer to consumer must bring about a corresponding increase in the price, and the secret of cheap milk lies in confining the profit as far as possible to the producer.

Keeping these general principles in view we may now proceed to a brief description of some important co-operative dairies working in this country. In Bengal the Dacca Co-operative Dairy has been transformed from a productive into a distributive society. It now gets its supply of milk, some 5 maunds daily, from the neighbouring cultivators who previously used to obtain advances from *goalas* and sell their milk through them. The cultivators have now been formed into co-operative societies and they have obtained advances from the Dacca Central Bank to pay off the *goalas* and purchase cattle. The cows are milked by recognized milkers and the society places the milk before the consumers. There is a great demand for milk as there is no adulteration in it, and the society is making a net profit of Rs. 50 per mensem. The scheme is the reverse of that adopted at Benares, where the owners of cattle have organized themselves to come into direct touch with the consumers.

The Gaolies Co-operative Society at Nagpur is now working successfully. A profit of over Rs. 306 per member and Rs. 42 for each milch animal was obtained. Their sales of milk increased by 50 per cent. while their sales of butter and cream were multiplied many times over. The success is largely due to the facilities given by the Department and the keen personal interest taken by Mr. Clouston. A second co-operative society has been formed on the same lines which shows that the *gaolies* have begun to appreciate the advantages of this form of co-operation.

The Co-operative Dairy at Benares incurred a loss partly owing to the higher cost of feeding stuffs and transport during the year and partly owing to a diminution in the supply of milk. The high prices especially of fodder, in the last two or three years, have told severely on milch cattle-owners; the members of the dairy society have consequently been unable to repay previously borrowed loans in full. The result has been that they are unable to get new loans to replace old or inferior cattle.

The Co-operative Dairy at Lucknow worked at a profit but it has a heavy load of outstanding dues from men who belonged to the original credit society and have not participated in the dairy business.

Two co-operative dairy societies have been organized to supply the Bombay market. One of these, the Jambul Hanuman dairy near Kalyan, employs an experienced manager and three assistants who keep the byres very clean and milk the buffaloes by the dry method. The society intends to extend its share capital and then proposes to open a retail shop of its own in Bombay City.

Large numbers of *gaolies* are moving out of Bombay Island as a result of more strict municipal regulations. It is proposed to settle them in groups along the Railway lines in Salsette, this position giving them unique facilities for milk transport into the city—working through their organization.

In Bihar a dairy society has been started on the outskirts of Gaya town. It is run more or less on the lines of the Vishveshwar Society of Benares, but has one advantage over it in that it has not to spend so much on the carriage of milk being much nearer to the bazaar. It has been found to work at a profit when properly managed. The difficulty so far has been to get a good manager.

Co-operative *ghi* societies are also springing up. There are two such in Allahabad. Their work has been entirely separated from the credit work done by village societies. The Allahabad *ghi* societies are flourishing. The members of *ghi* societies are also cultivators and they are more amenable to reason and method than milk-sellers. There is much less risk in the *ghi* business as the product is not as perishable.

Co-operative societies undertaking the supply of better seed or implements to their members or arranging for the supply of manures may now be briefly noticed.

In the United Provinces most of the Central Banks now act as informal agents for the supply of improved seed grain to members of societies. In this way Pusa 12 has been popularized over very wide areas. Groundnut has become a staple crop in certain parts of Unao and other districts. Improved varieties of cotton are sown by societies in all Western districts. Suitable types of sugarcane are also being tried in a number of new localities. In the Western districts, particularly in Bulandshahr, pumping installations with oil engines have been put up either by societies in their corporate capacity or by members with assistance from their societies. Some Banks and Societies have set apart small plots for the demonstration of new staples and varieties.

Some interesting schemes for irrigation on co-operative principles are also being tried in the United Provinces. One of these is the Kunwar Co-operative Society for pumping water from the Gumti. The manager of the central society who has interested himself greatly in the scheme feels convinced that even if it does not prove directly profitable, it will ultimately strengthen the financial position of the society by obviating the possibilities of crop failures. The second scheme is for a portable plant for working wells in the Bulandshahr District which will be in operation next *rabi* and the last for a tube well in Hardoi District.

An agricultural supply society has been registered at Mainpuri. The members are mostly landholders genuinely interested in the improvement of agriculture and many of them are also active participators in the co-operative credit movement. Sufficient capital has been obtained for growing good seed and also purchasing it in bulk and retailing the same to village societies and other cultivators. It is the first attempt in the United Provinces to separate the business of the supply of seed and other agricultural requisites from the ordinary activities of a

Central Society and the experiment will be watched with interest.

In the Punjab Union Banks in Jullunder, Gurdaspur and Hoshiarpur stock implements for sale. It is hoped that other banks will take up the work as their circumstances improve. Mr. Townsend, the Director of Agriculture, Punjab, is inclined to believe that it would be better to use the existing co-operative societies for the work of bringing agricultural improvements to the notice of the cultivators rather than create new co-operative societies purely for agricultural purposes.

In Bengal increasing use is being made of co-operative societies for furthering the use of improved implements, seed and manures.

In the Central Provinces the system of Agricultural Unions referred to in the previous report continued to expand. Seven more co-operative agricultural unions were registered during the year bringing the total in Berar to 11. There were also 19 unregistered unions under trial in the same tract, some of which will be ready for registration before another year when the members will have learnt the principles of co-operation as applied to agriculture. These Unions in addition to Seed Farms which were 71 in number in this circle have been of very great value in distributing the pure seed of *roseum* cotton. In the Northern Circle also Agricultural Unions have been started and are doing good work.

In connection with the manure supply societies in the Bombay Presidency the most important is a well managed manure society at Kelva Mahim in Thana. In the course of the year (1913-14) it sold 9,482 maunds of Gujerat *ghani*-pressed castor cake to its members at a rate of Rs. 16 per *khandi* as compared with a bazaar rate of Rs. 20 per *khandi*. Its success has encouraged the neighbouring villages of Agashi and Koprad with the help of Mr. Gonehalli to start similar societies. The manure store at Baramati, which is co-operative not in its management but only in the distribution of its profits, distributed 3,589 *khandis* of safflower, castor cake and *karanji* to 376 members at a cost of Rs. 57,603 during the year 1913-14. The Mutha Canal Society at Poona

which includes among its directorate Dr. H. H. Mann and two members of the Provincial Legislative Council, supplies the sugarcane growers of Hadapsar and the surrounding villages with castor cake, safflower cake and fish manure. As artificial manures can be used profitably in cultivating sugarcane and similar expensive crops, manure purchasing societies are only recommended in garden tracts or in irrigated areas where agriculturists have acquired some capital and experience.

It will be seen from the above that the Departments of Agriculture and Co-operation are getting more and more in touch with each other and this should lead in the near future to a considerable improvement in the rural economy of this country.

PART V.

Publications and Expenditure.

(1) **Publications.**—During the year under report 13 Memoirs and 14 Bulletins were published by the Imperial Department of Agriculture in India. The publication of a revised edition of the Manual of More Deadly Forms of Cattle Disease in India has been sanctioned by the Government of India. This small manual was last revised in 1903. It has now been brought up to date, and practically rewritten. It is now in the press and will be out shortly. It is hoped that this revision will add to the usefulness of this manual to intelligent cattle owners, and others.

The quarterly Agricultural Journal of India continued to be issued during the year. It is slowly but steadily becoming popular among those who take an interest in the agricultural development of this country.

The grant of Rs. 29,000 for publications has been made permanent.

The Bombay Department of Agriculture published during the year 9 bulletins and 14 leaflets on various subjects. The Poona College magazine continued to be issued.

Among the publications of the Madras Department the one deserving special mention is Mr. Wood's "Note-book of Agricultural Facts and Figures" modelled on Mr. McConnell's book for Western Farming. Nine bulletins and leaflets were issued during the year and widely distributed. The Agricultural Calendar was issued in five languages and nearly 74,000 copies distributed. This indicates that useful facts given in this

publication are brought to the notice of a very large section of the people concerned.

In the Central Provinces the monthly Agricultural and Co-operative Gazette continued to be published. It is issued in English, Hindi and Marathi.

In Bengal the Department published two leaflets and one bulletin besides issuing a year book of the Department in Bengali for the year 1319-20 B. S. The Fishery Branch of this Department issued three bulletins, the full titles of which are given in the Appendix.

The United Provinces Department published two bulletins in English, one dealing with the irrigation of wells in the Jaunpur District and the other with the level of the water in the sub-soil of the Gangetic plain. Mr. Leake published a paper on the factors controlling the ginning percentage of Indian cottons in the *Journal of Genetics*, volume IV, part I. A paper on the organic prosphoric acids of wheat by Mr. G. Clarke has been published in the Transactions of the Chemical Society.

The Bihar Department continued to publish the half-yearly Agricultural Journal. The College staff at Sabour contributed several papers to this Journal and also to the publications of the Imperial Department of Agriculture.

During the year under report the Department of Agriculture, Assam, published 3 leaflets and 3 bulletins in English. These will also be issued in the vernacular and widely distributed. Mr. Meggitt's paper on the studies of an acid soil in Assam was published in the Chemical Series of Memoirs issued by the Imperial Department of Agriculture.

The Burma Department published a bulletin on the Peas and Beans of Burma by Messrs. Thompstone and Sawyer. The Agricultural Calendar for 1915-16 was issued in Burmese.

A complete list of publications issued during the year by the Imperial and Provincial Departments of Agriculture in India is given in the Appendix.

(2) **Expenditure.** The total expenditure incurred by the Imperial Department of Agriculture during the financial year 1914-15 was as under :—

	Rs.
Office of the Agricultural Adviser to the Government of India and Director of the Institute . . .	2,03,046
Imperial Cotton Specialist	22,823
Chemical Section	41,807
Mycological Section	25,015
Entomological Section	43,142
Pathological Entomological Section . . .	25,662
Botanical Section	38,220
Bacteriological Section	31,592
Agricultural Section	71,341
TOTAL .	5,02,648

The amount of Rs. 2,03,046 shown as expenditure under the office of Agricultural Adviser to the Government of India and Director includes a sum of Rs. 10,000 placed at the disposal of the Agricultural Adviser to the Government of India for special agricultural experiments. The principal items of expenditure under this grant were :—(1) Purchase of two Ayrshire bulls for the Pusa Farm and the Agricultural Department of the Central Provinces; (2) Contribution to the Bacteriological Section, (3) Distribution of Pusa wheat seed, no. 12, in the United Provinces, (4) Experimental cotton cultivation by the Imperial Cotton Specialist, and (5) Purchase of silk yarns for sericulture experiments at Pusa.

A sum of Rs. 35,000 was provided in the budget of the Agricultural Adviser for 1914-15 for meeting the expenditure connected with the engagement of Mr. Hulme as Sugar Engineer in the United Provinces. This item formed a part of the grant of Rs. 1,10,000 mentioned in previous reports.

Rupees 15,000 were also paid during the year under report as grant-in-aid to the Indian Tea Association.

The expenditure incurred in the working of the Imperial Bacteriological Laboratory at Muktesar and Bareilly during the year 1914-15 was as follows:—

	Rs.
Salaries and travelling allowance of officers and establishment	81,355
Feed and keep of animals	72,196
Purchase of animals	14,483
Cost of chemicals and apparatus	7,494
Other miscellaneous expenditure	32,955
TOTAL	2,08,483

The total expenditure which the Provincial Departments of Agriculture incurred during the year under report amounted to Rs. 46,53,759. The details are shown below:—

	Rs.
Bengal	5,47,350
Bihar and Orissa	3,43,061
United Provinces of Agra and Oudh	6,60,392
Punjab	7,97,873*
Bombay	8,89,427†
Madras	4,99,996‡
Central Provinces	4,07,843
Burma	2,04,290§
Assam	2,62,218
North-West Frontier Province	41,309
TOTAL	46,53,759

* This includes Rs. 4,16,936 spent on buildings—Rs. 3½ lakhs for the Punjab Veterinary College, Lahore, and over Rs. 62,000 for the wheat elevator at Lyallpur.

† This includes Rs. 67,968 spent on Agricultural College and School buildings.

‡ This includes Rs. 1,456 spent in connection with the meeting of the Board of Agriculture and Rs. 8,006 debitable to Imperial Funds and Rs. 2,053 capital expenditure on purchase of land for Anakapalli Farm made in 1913-14.

§ This includes Rs. 18,900 spent on Botanical and other public gardens.

APPENDIX.

List of Agricultural Publications in India during 1914-15.

No.	Title	Author	Where published
	GENERAL AGRICULTURE.		
1	The *Agricultural Journal of India*, Vol. IX, Parts III and IV, and Vol. X, Parts I and II. Price per Part, Rs. 2; annual subscription, Rs. 6 or 8*s.* 6*d.*	Issued from the Agricultural Research Institute, Pusa, Bihar.	Messrs. Thacker, Spink & Co., Calcutta.
2	Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for 1913-14. Price, As. 8 or 9*d.*	Ditto.	Government Printing, India, Calcutta.
3	Report on the Progress of Agriculture in India for 1913-14. Price, As. 8 or 9*d.*	Agricultural Adviser to the Government of India, Pusa.	Ditto.
4	Notes on Sugar Machinery and Manufacture in Northern India, 1914. Bulletin No. 47 of the Agricultural Research Institute, Pusa. Price, As. 5 or 6*d.*	Peter Abel, Representative of the Harvey Engineering Company, Limited, Glasgow.	Ditto.
5	The Improvement of Tobacco Cultivation in Bihar. Bulletin No. 50 of the Agricultural Research Institute, Pusa. Price, As. 4 or 5*d.*	Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Ditto.
6	Soil Ventilation. Bulletin No. 52 of the Agricultural Research Institute, Pusa. Price, As. 3 or 4*d.*	Ditto.	Ditto.
7	Soil Erosion and Surface Drainage. Bulletin No. 53 of the Agricultural Research Institute, Pusa. Price, As. 4 or 5*d.*	Albert Howard, C.I.E., M.A., Imperial Economic Botanist.	Ditto.
8	The Manufacture of Jaggery in South India. Bulletin No. 55 of the Agricultural Research Institute, Pusa. Price, As. 4 or 5*d.*	A. Chatterton, C.I.E., Director of Industries and Commerce, Mysore.	Ditto.
9	Annual Report of the Board of Scientific Advice for India for the year 1913-14. Price, As. 14 or 1*s.* 4*d.*	Issued by the Board of Scientific Advice for India.	Ditto.
10	Agricultural Statistics of India for 1912-13, Vol. II. Price, Rl.	Department of Statistics, India, Calcutta.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
11	Estimates of Area and Yield of Principal Crops in India, 1913-14. Price, As. 4.	Department of Statistics, India, Calcutta.	Government Printing, India, Calcutta.
12	Annual Report of the Department of Agriculture, Bengal, for the year 1913-14. Price, As. 7 or 8*d*.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
13	*Krishi Samachar* or Year Book of the Department of Agriculture, Bengal, for 1321 B.S., in Bengali. Price, As. 6.	Ditto.	Ditto.
14	Season and Crop Report of Bengal for 1914-15. Price, R1 or 1*s*. 6*d*.	Ditto.	Ditto.
15	Annual Reports of the Expert Officers (Bengal) for the year ending 30th June 1914. Price, Rs. 1-10 or 1*s*. 6*d*.	Ditto.	Ditto.
16	Bulletin on Bonemeal Manure (in Bengali).	Ditto.	Ditto.
17	Agricultural Statistics of Bengal for 1913-14. Price, As. 8 or 9*d*.	Issued by the Government of Bengal, Revenue Department.	Ditto.
18	Annual Report of the Department of Agriculture, Bihar and Orissa, for the year 1913-14. Price, As. 8 or 9*d*.	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
19	Annual Reports of the Agricultural Stations, Bihar and Orissa, for 1913-14. Price, R1 or 1*s*. 6*d*.	Ditto.	Ditto.
20	Agricultural Statistics of Bihar and Orissa for 1913-14.	Ditto.	Ditto.
21	Season and Crop Report of Bihar and Orissa for 1914-15. Price, As. 6 or 6*d*.	Ditto.	Ditto.
22	*Agricultural Journal* (published half-yearly). Vol. II (Double No.) and Vol. III, No. 1. Annual subscription, R1.	Ditto.	Ditto.
23	The Preparation of Silage in Pits, Leaflet No. 2 of 1914 of the Department of Agriculture, Bihar and Orissa.	N. S. McGowan, Deputy Director of Agriculture, Bihar and Orissa.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
24	Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1914. Price, As. 8 or 9*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press United Provinces Allahabad.
25	Report on the Cawnpore Agricultural Station for the year ending 30th June 1914. Price, Rl or 1*s.* 6*d.*	Ditto.	Ditto.
26	Report on the Partabgarh Agricultural Station for the year ending 30th June 1914. Price, As. 8 or 9*d.*	Ditto.	Ditto.
27	Report on the Attarah (Banda) Agricultural Station for the year ending 30th June 1914. Price, As. 6 or 6*d.*	Ditto.	Ditto.
28	Report on the Benares Agricultural Station for the year ending 30th June 1914. Price, As. 6 or 6*d.*	Ditto.	Ditto.
29	Crop and Season Report of the United Provinces of Agra and Oudh, for the year ending 30th June 1914. Price, As. 8 or 9*d.*	Ditto.	Ditto.
30	Report of the Agricultural Stations of the Western Circle, United Provinces of Agra and Oudh, for the year 1913-14. Price, As. 8 or 9*d.*	Ditto.	Ditto.
31	Report on the Government Horticultural Gardens, Lucknow, for the year ending 31st March 1915. Price, As. 4 or 6*d.*	Ditto.	Ditto.
32	Report on the Government Botanical Gardens, Saharanpur, for the year ending 31st March 1915. Price, As. 4 or 6*d.*	Ditto.	Ditto.
33	Season and Crop Report of the United Provinces of Agra and Oudh for 1914-15. Price, As. 8 or 9*d.*	Ditto.	Ditto.
34	Monograph on the Irrigation of Wells of the Jaunpur District. Bulletin No. 32 of the United Provinces Department of Agriculture.	A. C. Walker, I.C.S., Collector of Jaunpur.	Ditto.
35	Note on the Level of the Water in the Sub-soil of the Gangetic plain. Bulletin No. 33 of the United Provinces Department of Agriculture. Price, As. 2.	E. A. Molony, I.C.S., Commissioner of Agra.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
36	Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June 1914. Price, As. 7 or 7*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
37	Year Book of the Punjab Agricultural Department, 1915.	Ditto.	Ditto.
38	Season and Crop Report of the Punjab for the year 1913-14.	Ditto.	Ditto.
39	Report on the Government Agri-Horticultural Gardens, Lahore, for the year 1914-15. Price, A. 1 or 1*d.*	Ditto.	Ditto.
40	Annual Report of the Department of Agriculture, Bombay Presidency, for the year 1913-14. Price As. 14 or 1*s.* 4*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
41	Season and Crop Report of the Bombay Presidency for 1913-14. Price, As. 5 or 6*d.*	Ditto.	Ditto.
42	Annual Report of the Surat Agricultural Station for 1913-14. Price, As. 14 or 1*s.* 4*d.*	Ditto.	Ditto.
43	Annual Report of the Dohad Agricultural Station for 1913-14. Price, As. 12 or 1*s.* 2*d.*	Ditto.	Ditto.
44	Annual Report of the Dhulia Agricultural Station for 1913-14. Price, As. 12 or 1*s.* 2*d.*	Ditto.	Ditto.
45	Annual Report of the Jalgaon Agricultural Station for 1913-14. Price, As. 12 or 1*s.* 2*d.*	Ditto.	Ditto.
46	Annual Report of the Nadiad Agricultural Station for 1913-14. Price, As. 9·3 or 1*s.*	Ditto.	Ditto.
47	Annual Report of the Gokak Agricultural Station for 1913-14. Price, As. 12 or 1*s.* 2*d.*	Ditto.	Ditto.
48	Annual Report of the Gadag Agricultural Station for 1913-14. Price, As. 12 or 1*s.* 2*d.*	Ditto.	Ditto.
49	Annual Report of the Dharwar Agricultural Station for 1913-14. Price, R1 or 1*s.* 6*d.*	Ditto.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
50	Annual Report of the Alibag Agricultural Station for 1913-14. Price, As. 10 or 11*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
51	Annual Report of the Ratnagiri Agricultural Station for 1913-14. Price, As. 6 or 6*d.*	Ditto.	Ditto.
52	Annual Report of the Mirpurkhas Agricultural Station for 1913-14. Price, As. 7 or 8*d.*	Ditto.	Ditto.
53	Annual Report of the Landhi Agricultural Station for 1913-14. Price, As. 4 or 5*d.*	Ditto.	Ditto.
54	Annual Report of the Larkana Agricultural Station for 1913-14. Price, As. 6 or 7*d.*	Ditto.	Ditto.
55	Annual Report of the Manjri Agricultural Station for 1913-14. Price, As. 7 or 8*d.*	Ditto.	Ditto.
56	Annual Report of the Experimental plots in Sholapur and Satara Districts for 1913-14. Price, As. 4 or 5*d.*	Ditto.	Ditto.
57	Annual Report of the Ganeshkhind Garden for 1913-14. Price, As. 3 or 4*d.*	Ditto.	Ditto.
58	Annual Report of the Kirkee Civil Dairy for 1913-14. Price, As. 2 or 2*d.*	Ditto.	Ditto.
59	Annual Report of the Poona Agricultural College Farm for 1913-14. Price, Rs. 1-8 or 2*s.* 6*d.*	Ditto.	Ditto.
60	Note on Sugar Industry and Modern Methods of Sugar Manufacture. Bulletin No. 60 of the Department of Agriculture, Bombay. Price, As. 12 or 1*s.* 2*d.*	G. N. Sahasrabuddhe, L.Ag.	Ditto.
61	Alkali or Kalar Experiments and Completion Report of the Daulatpur Reclamation Station, Sind. Bulletin No. 64 (1914) of the Department of Agriculture, Bombay. Price, As. 14 or 1*s.* 4*d.*	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture, Sind.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
62	An Examination of the Seed Supply of the Sholapur District. Bulletin No. 67 (1914) of the Department of Agriculture, Bombay. Price, As. 3 or 3*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
63	A Note on Well Boring. Bulletin No. 68 (1914) of the Department of Agriculture, Bombay. Price, As. 5 or 6*d.*	W. M. Schutte, Agricultural Engineer to the Government of Bombay.	Ditto.
64	Improvement of Cotton in the Bombay Presidency. Bulletin No. 70 (1915) of the Department of Agriculture, Bombay. Price, As. 3-6 or 4*d.*	K. D. Kulkarni, Cotton Supervisor, Northern Division, and G. L. Kottur, Cotton Supervisor, Southern Division, Bombay Presidency.	Ditto.
65	Experiments with the Automatic Water Finder in the Trap Region of Western India. Bulletin No. 72 (1915) of the Department of Agriculture, Bombay. Price, As. 4 or 5*d.*	Harold H. Mann, D.Sc., Principal, Poona Agricultural College.	Ditto.
66	Hand List of Plants, Seeds and Bulbs available for distribution in the Ganeshkhind Botanical Garden, Kirkee, India. Bulletin No. 73 (1915) of the Department of Agriculture, Bombay. Price, As. 2 or 3*d.*	G. B. Patwardhan, B.Sc., F.R.H.S., Superintendent, Ganeshkhind Botanical Garden, Kirkee.	Ditto.
67	Notes on the Cattle of the Bombay Presidency. Bulletin No. 75 (1915) of the Department of Agriculture, Bombay.	.....	Ditto.
68	Artificial Manures, Experiments on their value for Crops in Western India. Bulletin No. 76 (1915) of the Department of Agriculture, Bombay.	.....	Ditto.
69	*Packat* (trash) as manure for Sugarcane Crop. Leaflet No. 6 (1914).	Issued by the Department of Agriculture, Bombay.	Ditto.
70	Cultivation of Chillies. Leaflet No. 7 (1914).	Ditto.	Ditto.
71	Earthing up of Sugarcane by the Sabul plough. Leaflet No. 8 (1914).	Ditto.	Ditto.
72	Improved Furnaces for Gul-Boiling. Leaflet No. 9 (1914).	Ditto.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
73	Cultivation of Onions. Leaflet No. 2 (1915).	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
74	Cultivation of Bananas. Leaflet No. 3 (1915).	Ditto.	Ditto.
75	The Polishing of Turmeric for the market. Leaflet No. 4 (1915).	Ditto.	Ditto.
76	The Meston plough for the Konkan. Leaflet No. 5 (1915).	Ditto.	Ditto.
77	The Preservation of Seed. Leaflet No. 6 (1915).	Ditto.	Ditto.
78	Crops cultivated on *bandhs*. Leaflet No. 7 (1915).	Ditto.	Ditto.
79	The proper planting of cane sets. Leaflet No. 8 (1915).	Ditto.	Ditto.
80	Storage of seed potatoes at Landhi Government Farm. (Leaflet for Sind only).	Ditto.	Ditto.
81	New implements useful for Sind. (Leaflet for Sind only.)	Ditto.	Ditto.
82	The Fodder Problem in the Bombay Presidency. Price, As. 2.	Issued by the Government of Bombay.	Ditto.
83	Agricultural Engineering in the Bombay Presidency. Price, As. 2.	Ditto.	Ditto.
84	Poona Agricultural College Calendar, 1915-16.	Issued by the Department of Agriculture, Bombay.	Ditto.
85	Report on the Oil Pressing Industry of the Bombay Presidency.	Y. G. Pandit . .	Ditto.
86	Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1913-14. Price, As. 3 or 3*d*.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
87	Madras Agricultural Calendar, 1915-16. Price, A. 1.	Ditto.	Ditto.
88	Season and Crop Report of the Madras Presidency for 1913-14. Price, As. 4.	Board of Revenue (Revenue Settlement, Survey, Land Records and Agriculture), Madras.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
89	Report of the Experimental work of the Palur Agricultural Station for 1913-14. Price, As. 1½ or 2*d.*	G. D. Mehta, L.Ag., B.A., N.D.A., N.D.D., Extra Deputy Director of Agriculture, Central Division, Madras Presidency.	Government Press, Madras.
90	Report of the Experimental work of the Taliparamba Agricultural Station for 1913-14. Price, A. 1 or 1*d.*	H. C. Sampson, B.Sc., Deputy Director of Agriculture, Southern Division, Madras Presidency.	Ditto.
91	Report of the Experimental work of the Mangamallur Agricultural Station for 1913-14. Price, A. 1 or 1*d.*	Ditto.	Ditto.
92	Report of the Experimental work of the Koilpatti Agricultural Station for 1913-14. Price, A. 1 or 1*d.*	Ditto.	Ditto.
93	Report of the Experimental work of the Hagari Agricultural Station for 1913-14. Price, A. 1 Pies 9 or 2*d.*	Ditto.	Ditto.
94	Possible use for oil engines when not required for pumping. Leaflet No. 8 (1914) of the Madras Department of Agriculture.	R. W. B. C. Wood, M.A., Principal, Agricultural College, Coimbatore.	Ditto.
95	Indigo. Leaflet No. 9 (1914) of the Madras Department of Agriculture.	G. D. Mehta, L.Ag. B.A., N.D.A., N.D.D., Extra Deputy Director of Agriculture, Central Division.	Ditto.
96	What the ryot has to say about the advantage of *dhaincha*. Leaflet No. 1 (1915) of the Madras Department of Agriculture.	S. Subramania Iyer, Farm Manager.	Ditto.
97	What the ryot has to say about the advantage of "Wild Indigo." Leaflet No. 2 (1915) of the Madras Department of Agriculture.	Ditto.	Ditto.
98	What the ryot has to say about the advantage of "Triangular Harrow." Leaflet No. 3 (1915) of the Madras Department of Agriculture.	Ditto.	Ditto.
99	A Note Book of Agricultural Facts and Figures. Price, As. 14.	R. Cecil Wood, M.A., Principal Agricultural College, Coimbatore.	Ditto.
100	Report on the Working of the Department of Agriculture, Central Provinces and Berar, for 1913-14. Price, R1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Nagpur.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
101	Report on the Agricultural Stations in the Central Provinces and Berar, for the year 1913-14. Price, R1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Nagpur.
102	Report on the Management of the Provincial and District Gardens, Central Provinces and Berar, for 1913-14.	Ditto.	Ditto.
103	Season and Crop Report of the Central Provinces and Berar for 1913-14. Price, As. 8 or 9*d.*	Ditto.	Ditto.
104	*The Agricultural and Co-operative Gazette*, July 1914 to June 1915 (monthly). Annual subscription, R1 ; single copy, As. 2.	Ditto.	Desh Sevak Press, Nagpur.
105	Report on the Operations of the Department of Agriculture, Burma, for the year 1913-14. Price, As. 6 or 7*d.*	Issued by the Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
106	Report of the Mandalay Agricultural Station for 1913-14.	Ditto.	Ditto.
107	The Burma Agricultural Calendar for 1914-15.	Ditto.	Ditto.
108	Season and Crop Report of Burma for the year ending 30th June 1915. Price, As. 8 or 9*d.*	Ditto.	Ditto.
109	Burma Agricultural Calendar for 1915-16 (in Burmese).	Ditto.	Ditto.
110	Report of the Agricultural Department, Assam, for the year ending 30th June 1914. Price, As. 8 or 9*d.*	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
111	Report on the Season and Crops of Assam for 1914-15. Price, As. 8 or 9*d.*	Ditto.	Ditto.
112	Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June 1914.	Ditto.	Ditto.
113	Annual Report of the Upper Shillong Agricultural Experiment Station for the year ending 30th June 1914.	Ditto.	Ditto.
114	Annual Report of the Fruit Experiment Station, Shillong, for the year ending 30th June 1914.	Ditto.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
115	Annual Report of the Karimganj Agricultural Experiment Station, for the year ending 30th June 1914.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing office, Shillong.
116	Annual Report of the Kamrup Sugarcane Experiment Station for the year ending 30th June 1914.	Ditto.	Ditto.
117	Preserving Fodder for winter in the Khasi Hills. Bulletin No. 1 of 1915.	Ditto.	Ditto.
118	Potato Cultivation in the Assam Hills. Bulletin No. 3 of 1914.	Ditto.	Ditto.
119	Bonemeal as a manure for wet rice land in the Khasi and Jaintia Hills. Leaflet No. 3 of 1914.	Ditto.	Ditto.
120	Price list of the Central Seed Depôt at Gauhati. Leaflet No. 1 of 1915.	Ditto.	Ditto.
121	Proper Conservation of Cattle Dung and Urine. Leaflet No. 1 of 1914. (In English, Bengali, Assami, and Khasi.)	Ditto.	Ditto.
122	Summary of Remarks on the Kharif Crop of the North-West Frontier Province. Price, As. 4 or 4*d*.	.....	North-West Frontier Province Government Press, Peshawar.
123	Annual Report of the Peshawar Agricultural Station at Tarnab in the North-West Frontier Province for the year ending 30th June 1914.	Department of Agriculture, North-West Frontier Province.	Messrs. Thacker, Spink & Co., Calcutta.
124	Report of an Agricultural Tour in Europe, America, and Japan during 1912-13.	Leslie Coleman, M.A., Ph.D., Director of Agriculture, Mysore.	Government Press, Bangalore.
125	Report on Agricultural Education, Bulletin No. 3 of the Department of Agriculture, Mysore.	Issued by the Department of Agriculture, Mysore.	Ditto.
126	Distribution of Cambodia Cotton Seed, Circular No. 9 of the Department of Agriculture, Mysore.	Ditto.	Ditto.
127	Smut on *Jola*, Circular No. 10 of the Department of Agriculture, Mysore.	Ditto.	Ditto.
128	About the Cultivation of Cambodia Cotton, Circular No. 11 of the Department of Agriculture, Mysore.	Ditto.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*concld.*		
129	Annual Report of the Department of Agriculture, Mysore, for 1913-14.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
130	Mysore Agricultural Calendar, 1915. Price, 1 anna.	Ditto.	Ditto.
131	An Improved Method of Making Jaggery. Bulletin No. 21 of the Mysore Industries and Commerce Committee.	Alfred Chatterton, F.C., G.I., C.I.E., Director of Industries and Commerce, Mysore.	Vokkaligera Sangha Press, Bangalore.
132	Lift Irrigation. Mysore Economic Conference Bulletin No. 28 (1915).	A. Chatterton, C.I.E., Director of Industries and Commerce, Mysore.	National Press, Bangalore.
133	Coffee. Its Cultivation and Manuring in South India. Bulletin No. 6 of 1915 of the United Planters' Association of Southern India. (General Series.)	R. D. Anstead, B.A., Scientific Officer for Planting Industries in Southern India.	Vokkaligera Sangha Press, Bangalore.
134	Cotton Seed Products in India . .	Issued by the Indian Cotton Oil Co., Ld., Bombay.	Published by R. L. Sutaria, for the Indian Cotton Oil Co., Ltd., 14, Hummum Street, Fort, Bombay.
135	The *Journal of the Madras Agricultural Students' Union* (monthly). Annual subscription, R1.	Madras Agricultural Students' Union.	Literary Sun Press, Coimbatore.
136	*Quarterly Journal of the Indian Tea Association*, Parts III and IV of 1914 and I and II of 1915. Price, As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
137	Suggestions for the Manurial Treatment of Tea Soils, 1915.	G. D. Hope, B.Sc., Ph. D., Scientific Officer of the Indian Tea Association, and P. H. Carpenter, F.I.C., Assistant Scientific Officer.	Ditto.
138	*Indian Poultry Gazette* (monthly). Subscription, Rs. 3 per annum.	Indian Poultry Club, Lucknow.	Mafasilite Electric Printing Works, Mussoorie.
139	*Poona Agricultural College Magazine* (quarterly), Vol. VI, Nos. 1-4. Annual subscription, Rs. 2, single copy, As. 9.	College Magazine Committee, Poona.	Arya Bhushan Press, Poona.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY.		
140	The System Potassium Nitrate, Sodium Chloride, Water. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 7. Price, R1 or 1*s.* 6*d.*	J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist and Jatindra Nath Mukerji, B.A., B.Sc., First Assistant to the Imperial Agricultural Chemist.	Messrs. Thacker, Spink & Co., Calcutta.
141	The Systems (A) Water, Magnesium Carbonate and Carbonic Acid, (B) Water, Calcium Carbonate, Magnesium Carbonate, and Carbonic Acid. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 8. Price, R1 or 1*s.* 6*d.*	J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist, and Jatindra Nath Sen, M.A., Supernumerary Agricultural Chemist.	Ditto.
142	Studies of an Acid Soil in Assam. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. III, No. 9. Price, R1-8 or 2*s.* 6*d.*	A. A. Meggitt, B.Sc., Agricultural Chemist, Assam.	Ditto.
143	The Gases of Swamp Rice Soils, Part II, their Utilization for the Aeration of the Roots of the Crop. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 1. Price, R1 or 1*s.* 6*d.*	W. H. Harrison, M.Sc., Government Agricultural Chemist, Madras, and P. A. Subramania Aiyer, B.A., Assistant to the Government Agricultural Chemist, Madras.	Ditto.
144	Investigation on Usar Land in the United Provinces.	J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist.	Government Press, U. P., Allahabad.
145	The use of Sweet Jowar (*Sorghum* sp.) as a source of commercial sugar or as fodder and the variation in the composition of the crop during growth. Bulletin No. 41 of the Agricultural Research Institute, Pusa. Price, As. 2 or 3*d.*	H. E. Annett, B.Sc., F.I.C., Agricultural Chemist to the Government of Bengal.	Government Printing, India, Calcutta.
146	Notes on Cane Crushing in the United Provinces. Bulletin No. 42 of the Agricultural Research Institute, Pusa. Price, As. 2 or 3*d.*	G. Clarke, F.I.C., Agricultural Chemist to the Government of United Provinces, Naib Hussain and S. C. Bannerji, assisted by Lakshmi Shankar.	Ditto.
147	The Acid Secretion of the Gram Plant (*Cicer arietinum*). Bulletin No. 45 of the Agricultural Research Institute, Pusa. Price, As. 2 or 3*d.*	D. L. Sahasrabuddhe, B.Sc., L.Ag., Assistant Professor of Chemistry, Agricultural College, Poona.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY—*contd.*		
148	The Experimental Error in Field Trials with Sugarcane and the Effect on this Error of various methods of sampling. Bulletin No. 49 of the Agricultural Research Institute, Pusa. Price As. 3 or 4*d*.	H. E. Annett, B.Sc., F.I.C., Agricultural Chemist to the Government of Bengal, Dacca.	Government Printing, India, Calcutta.
149	Well waters from the trap area of Western India. Bulletin No. 74 (1915) of the Department of Agriculture, Bombay. Price, As. 6 or 7*d*.	Harold H. Mann, D.Sc., Principal, Poona Agricultural College.	Government Central Press, Bombay.
	BOTANY.		
150	The Influence of the Environment on the Milling and Baking qualities of Wheat in India, No. 3. The Experiments of 1911-12. Memoirs of the Department of Agriculture in India Botanical Series, Vol. VI, No. 8 Price, R1 or 1*s*. 6*d*.	A. Howard, C.I.E., M.A., Imperial Economic Botanist, H. M. Leake, M.A., Government Economic Botanist, United Provinces, and G. L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.
151	Studies in Indian Sugarcanes, No. 1, Punjab Canes. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 1. Price, R3-8 or 5*s*. 6*d*.	C. A. Barber, Sc.D., Government Sugarcane Expert, Madras.	Ditto.
152	The Distinguishing Characters of Sugarcanes cultivated at Sabour, with a note on Chemical Characters. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 2. Price, R1-8 or 2*s*. 6*d*.	E. J. Woodhouse, M.A., Economic Botanist to the Government of Bihar and Orissa, S. K. Basu, M.A. (Cantab.), Assistant Professor, Agricultural College, Sabour, and C. S. Taylor, B.A., Agricultural Chemist to the Government of Bihar and Orissa.	Ditto.
153	First Report on the Improvement of Indigo in Bihar (with notes on Drainage and on Green-manuring). Bulletin No. 51 of the Agricultural Research Institute, Pusa. Price, As. 4 or 5*d*.	Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Government Printing, India, Calcutta.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	BOTANY—*contd.*		
154	Second Report on the Improvement of Indigo in Bihar. Bulletin No. 54 of the Agricultural Research Institute, Pusa. Price, As. 2 or 3*d*.	Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist.	Government Printing, India, Calcutta.
155	Annual Report on the Experimental Work of the Economic Botanist and his Staff for 1913-14. Price, As. 5 or 6*d*.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
156	Grape growing in the Nasik District. Bulletin No. 71 (1915) of the Department of Agriculture, Bombay. Price, As. 9 or 10*d*.	H. V. Gole . .	Ditto.
157	The Peas and Beans of Burma. Bulletin No. 12 of the Department of Agriculture, Burma. Price, As. 8 or 9*d*.	E. Thompstone, B.Sc., Deputy Director of Agriculture, Burma, and A. M. Sawyer, Assistant Botanist, Burma.	Government Press, Rangoon.
158	Some Aspects of Modern Tea Pruning .	G. D. Hope, B.Sc., Ph.D., Scientific Officer, Indian Tea Association and P. H. Carpenter, F.I.C., Assistant Scientific Officer.	Catholic Orphan Press, Calcutta.
	MYCOLOGY.		
159	The Potato Blight in India. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 3. Price, Rl or 1*s*. 6*d*.	Jehangir Fardunji Dastur, B.Sc., First Assistant to the Imperial Mycologist.	Messrs. Thacker, Spink & Co., Calcutta.
160	Bordeaux Mixture as a preventive of Potato Disease. Bulletin No. 2 of 1914.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
161	A List of Diseases of Economic Plants occurring in the Bombay Presidency. Bulletin No. 65 of the Department of Agriculture, Bombay. Price, As. 4 or 5*d*.	H. M. Chibber, M.A., Assistant Professor of Botany, Agricultural College, Poona.	Government Central Press, Bombay.
162	The *Mahali* or *Koleroga* Disease of Areca nuts.	W. MacRae, M.A., B.Sc., Government Mycologist, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	ENTOMOLOGY.		
163	How to improve Silk-Reeling in Bengal. Bulletin No. 44 of the Agricultural Research Institute, Pusa. Price, As. 4 or 5*d*.	M. N. De, Sericultural Assistant, Pusa.	Government Printing, India, Calcutta.
164	Bee-Keeping. Bulletin No. 46 of the Agricultural Research Institute, Pusa. Price, As. 14 or 1*s*. 4*d*.	C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Ditto.
165	First Report on the Experiments carried out at Pusa to improve the Mulberry Silk Industry, compiled under the direction of the Imperial Entomologist. Bulletin No. 48 of the Agricultural Research Institute, Pusa. Price, As. 6 or 7*d*.	M. N. De, Sericultural Assistant, Pusa.	Ditto.
166	*Hindustan me Lakh ki kast*. Hindi translation of Bulletin No. 28 of the Agricultural Research Institute, Pusa. Price, As. 8.	C. S. Misra, B.A., First Assistant to the Imperial Entomologist, Pusa.	Baptist Mission Press, Calcutta.
167	*Tunt Resham Shilp Sambandhe Updesh*. Bengali translation of Bulletin No. 39 of the Agricultural Research Institute, Pusa. Price, As. 4.	M. N. De, Sericultural Assistant to the Imperial Entomologist, Pusa.	Ditto.
168	Some South Indian Insects and other Animals of Importance considered especially from an economic point of view. Price, R6 or 9*s*.	T. Bainbrigge Fletcher, F.E.S., F.Z.S., Imperial Entomologist (*late* Government Entomologist, Madras).	Government Press, Madras.
169	The Palm Leaf Caterpillar. Leaflet No. 1 of 1915 (in English and Bengali).	P. C. Sen, Entomological Collector, Bengal.	Obtainable from the office of the Director of Agriculture, Bengal, Calcutta.
170	The Palm-Beetle. Leaflet No. 2 of 1915 (in English and Bengali).	Ditto.	Ditto.
171	Report on the Fishery Investigations in Bengal and Bihar and Orissa with recommendations for future work. Fishery Bulletin No. 5. Price, As. 6 or 6*d*.	T. Southwell, A.R.C.S., F.L.S., F.Z.S., Deputy Director of Fisheries, Bengal and Bihar and Orissa.	Bengal Secretariat Book Depôt, Calcutta.
172	Certain details relating to the fish traffic in Bengal and Bihar and Orissa for the year ending 31st March 1914. Fishery Bulletin No. 6. Price, As. 2 or 3*d*.	Ditto.	Ditto.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—*contd.*		
173	Report on Fresh-water pearlmussel fisheries in Bengal and Bihar and Notes on the Terrapin and Mud-turtle fisheries in Bengal. Fishery Bulletin No. 7. Price, As. 7 or 8*d.*	T. Southwell, A.R.C.S., F.L.S., F.Z.S., Deputy Director of Fisheries, Bengal and Bihar and Orissa, and B. B. Das, M.A., Superintendent of Fisheries.	Bengal Secretariat Book Depôt, Calcutta.
174	Notes on the Spraying of Tea. Paper No. 1 of 1915 of the Indian Tea Association.	E. A. Andrewes, B.A., Entomologist, and A. C. Tunstall, B.Sc., Mycologist.	Catholic Orphan Press, Calcutta.
175	Instructions for Collecting and Forwarding Specimens of Insects damaging Crops. Leaflet No. 2 of the Department of Agriculture, Assam. (In English, Bengali, Assami and Khasi.)	Department of Agriculture, Assam.	Secretariat Press, Shillong.
176	Sericulture in Mysore. Plans of Stands and Trays for the new models of Silk-Worm Rearing House.	Signor W. Mari, Silk Expert, Mysore.	Government Press, Bangalore.
177	Sericulture in Mysore. Some Illustrations.	Ditto.	Ditto.
178	Rational Sericulture—Plans of Rearing Schools and Rearing Houses.	Ditto.	Ditto.
179	Sericulture. Report of work done by Signor W. Mari during the year 1914.	Issued by the Mysore Economic Conference, Agricultural Committee.	National Press, Bangalore.
180	The Rice Stem Borer in the Konkan. Bulletin No. 69 (1915) of the Department of Agriculture, Bombay. Price, As. 3-6 or 4*d.*	R. S. Kasargode, L.Ag., Lecturer in Entomology, Poona Agricultural College, and V. G. Deshpande, B.Ag.	Government Central Press, Bombay.
181	The Locust of the North-West. Leaflet No. 1 (1915).	Issued by the Department of Agriculture, Bombay.	Ditto.
	AGRICULTURAL BACTERIOLOGY.		
182	A new Nitrite-forming Organism. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. I, No. 3. Price, ₹1 or 1*s.* 6*d.*	N. V. Joshi, B.A., B.Sc., L.Ag., First Assistant to the Imperial Agricultural Bacteriologist.	Messrs. Thacker, Spink & Co., Calcutta.

List of Agricultural Publications in India during 1914-15—contd.

No.	Title	Author	Where published
	VETERINARY.		
183	Bursati. Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. II, No. 5. Price, R1-8 or 2*s*. 3*d*.	Major J. D. E. Holmes, C.I.E., M.A., D.Sc., M.R.C.V.S., Imperial Bacteriologist, Muktesar.	Messrs. Thacker, Spink & Co., Calcutta.
184	Experiments on the Treatment of Surra in Camels. Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. II, No. 6. Price, R1 or 1*s*. 6*d*.	H. E. Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist.	Ditto.
185	Anthrax. Some Experiments on the Immunizing Effect of the simultaneous Injection of an Anthrax attenuated Virus and Anthrax Anti-Serum. Memoirs of the Department of Agriculture, Veterinary Series, Vol. II, No. 7. Price, R1 or 1*s*. 6*d*.	Major J. D. E. Holmes, C.I.E., M.A., D.Sc., M.R.C.V.S., Imperial Bacteriologist, Muktesar.	Ditto.
186	A Note on the Effect of Heat on the Rinderpest Immune Bodies. Bulletin No. 43 of the Agricultural Research Institute, Pusa. Price, As. 2 or 3*d*.	Ditto.	Government Printing India, Calcutta.
187	Annual Report of the Imperial Bacteriologist, Muktesar Laboratories, for the year 1913-14. Price, As. 3 or 4*d*.	Issued by the Agricultural Adviser to the Government of India, Pusa.	Ditto.
188	Report of the Civil Veterinary Department, Bengal, for the year 1913-14. Price, As. 9 or 10*d*.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
189	Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1913-14.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
190	A note on Surra in Camels . . .	H. E. Cross, M.R.C.V.S., D.V.H., A.Sc., Camel Specialist.	Ditto.
191	Note on Cattle Census in the Punjab and Returns.	Issued by the Department of Agriculture, Punjab.	Ditto.
192	Annual Report of the Camel Specialist for 1913-14.	Ditto.	Ditto.
193	Annual Administration Report of the Bombay Veterinary College and Civil Veterinary Department in the Bombay Presidency, including Sind, for the year 1913-14. Price, As. 7 or 8*d*.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1914-15—concld.

No.	Title	Author	Where published
	VETERINARY—*concld.*		
194	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1913-14. Price, R1.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
195	Report of the Civil Veterinary Department, Burma, for the year ending 31st March 1914. Price, As. 8 or 9*d*.	Issued by the Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
196	Annual Report of the Bengal Veterinary College for 1914-15.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
197	Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March 1915. Price, As. 8 or 9*d*.	Issued by the Department of Land Records and Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
198	The United Provinces Cattle Census of 1915.	Ditto.	Ditto.
199	Report on the Dhanni Breed of Cattle. Price, R1 or 1*s*. 6*d*.	D. Meadows, M.R.C.V.S., Superintendent, Civil Veterinary Department, North Punjab.	Government Printing, Punjab, Lahore.
200	Some Common Ailments of Cattle. Leaflet No. 1 of the Department of Agriculture, Madras.	F. Ware, Superintendent, Civil Veterinary Department, Madras.	Government Press, Madras.
201	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1914-15 Price, R1.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Nagpur.
202	Report on the Civil Veterinary Department, Burma, for the year ending 31st March 1915. Price, As. 8 or 9*d*.	Issued by the Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
203	Report on the Working of the Civil Veterinary Department, Mysore, during the year 1913-14.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.

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REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1915-16

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1917

TABLE OF CONTENTS

	Page.
Introductory	i
Chapter I.—Progress in Administration—	
(*a*) The Agricultural Adviser	1
(*b*) The Pusa and Muktesar Staff	2
(*c*) The Staff in the Provinces	3
(*d*) War Services of the Staff	8
(*e*) Conferences	10
Chapter II.—Progress in Scientific Research—	
(*a*) Agriculture	12
(*b*) Chemistry	33
(*c*) Botany	39
(*d*) Mycology	46
(*e*) Entomology	50
(*f*) Pathological Entomology	56
(*g*) Agricultural Bacteriology	57
(*h*) Agricultural Engineering	61
Chapter III.—Progress in Demonstration and Co-operation—	
(*a*) Demonstration	66
(*b*) Co-operation	84
Chapter IV.—Progress in Education	90
Chapter V.—Progress in Veterinary work	95
Chapter VI.—Publications	101
Chapter VII.—Expenditure	104
Appendix.—List of Agricultural Publications in India during 1915-16	107

SOME OF THE PEDIGREE DAIRY HERD OF MONTGOMERY CATTLE AT PUSA.

INTRODUCTORY

TWO reports connected with agriculture issue annually from this office. One is the Report of the Pusa Institute which is purely scientific and contains the reports of the various branches of the Institute written by the officers in charge of the sections. It appeals less to the general public than to workers in similar branches of science in India and other countries and, from the nature of the case, is written in a scientific and not in a popular style.

The second report is the "Report on the Progress of Agriculture in India" and is intended to give a general idea of the principal work which is being done by the various Departments. It is based on the reports issued annually by each Provincial Director and contains also reference to the work done at Pusa. It is intended more for the general reader interested in one or other of the aspects of agricultural progress. While it is improbable that all readers will have an equal interest in the various branches of activity which are described, it is hoped that the present arrangement of the report will enable some to pick out the portions in which they are interested, while the less critical will obtain a general conspectus of the varied work now being done for the progress of agriculture. The report refers to the year ending the 30th of June 1916; and its compilation has to await the issue of the Provincial Reports dealing with the same period.

I desire to express my obligations to Mr. Wynne Sayer, Assistant to the Agricultural Adviser to the Government of India, for his assistance in the compilation of this report as also for the general help he has rendered me since I have taken over charge of this office.

J. MACKENNA,
Agricultural Adviser to the Government of India.

PUSA,
December 19, 1916.

REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1915-16

CHAPTER I.

Progress in Administration.

(*a*) The Agricultural Adviser.

Mr. B. Coventry, C.I.E., Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa, retired from the service of Government on the 31st March, 1916, and I took over charge of the Department. Mr. Coventry has been associated with this Department from the very inception of the Pusa Institute in 1904, and has been responsible both for the successful foundation and administration of the Institute and for the healthy development of the Department in general. It would not be too much to say that Government as well as India at large owe him a deep debt of gratitude for his devoted labours in the furtherance of the interests of agriculture in India.

Mr. Wynne Sayer held the post of Assistant to the Agricultural Adviser to the Government of India throughout the year and has recently been confirmed in the service. He has taken over a large share of the work connected with the publications of the Imperial Department of Agriculture and the management of the Pusa Estate. This enables the Agricultural

Adviser to the Government of India to devote more time to inspection and touring.

Mr. Coventry visited the jute districts in Bengal in the monsoon and inspected the jute seed selection work of Mr. Finlow. He also visited the various experimental and demonstration farms in Bengal and conferred with the Local Government at Dacca with regard to the development of work of the Local Agricultural Department. On return from Bengal he went to the Central Provinces to inspect the cotton, wheat and rice work carried on there and thence he proceeded to Simla. In the beginning of the cold weather he visited Central India in connection with the formation of Agricultural Departments in the different States and to advise generally on the possibilities of agricultural improvement. In November and December he toured in the Punjab and inspected the work being done on cotton and wheat in that Province.

I took over charge of the Department in the beginning of April. During the month I proceeded to Bareilly to discuss with the Imperial Bacteriologist certain matters in connection with the Muktesar Laboratory, and reached Simla at the end of April.

(*b*) The Pusa and Muktesar Staff.

The following changes occurred in the staff of the Imperial Department of Agriculture and of the Muktesar Laboratory.

Mr. J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist, proceeded on combined leave on 16th September, 1915, preparatory to retirement. He has since joined the Cheshire Regiment as a Major. I wish to place on record my appreciation of the valuable work done by Mr. Leather during his long service in the Department. Mr. J. N. Sen, M.A., F.C.S., Supernumerary Agricultural Chemist, has been officiating as Imperial Agricultural Chemist, pending permanent arrangements to fill the post.

Mr. E. J. Butler, M.B., F.L.S., Imperial Mycologist, returned from leave in November and resumed charge of his section. The post of Second Imperial Mycologist was created during the year and Mr. Shaw, Supernumerary Mycologist, was appointed to it.

In addition to his ordinary duties Mr. T. Bainbrigge Fletcher, Imperial Entomologist, has held charge also of the duties of the Imperial Pathological Entomologist during the absence on leave of Mr. F. M. Howlett. The post of Supernumerary Entomologist remained vacant owing to the impossibility of obtaining a suitable candidate during the war.

The Agricultural Section was in charge of Mr. S. Milligan, M.A., B.Sc., till 2nd June, 1916, when he was transferred to Bengal to officiate as Director of Agriculture and Mr. G. S. Henderson, N.D.A., N.D.D., a Deputy Director in the Bombay Presidency, was appointed to officiate as Imperial Agriculturist.

A special temporary post of Indigo Research Chemist was created during the year. This has been filled by the appointment of Mr. W. A. Davis, B.Sc., F.C.S., a member of the Rothamsted Staff, who joined his appointment at Pusa at the end of May. Mr. Davis has been specially appointed to investigate the possibility of manufacturing indigo in a paste of standard quality, with a view to regaining and retaining a market for natural indigo.

The Bacteriological Laboratory at Muktesar was in charge of Mr. A. W. Shilston, who officiated as Imperial Bacteriologist. Dr. R. V. Norris, M.Sc., D.Sc., Physiological Chemist, joined the Indian Army Reserve of Officers in October, 1915.

Work in connection with the inoculation of cattle in the military dairies having been taken up by the Muktesar Laboratory an extra post of Deputy Superintendent was created for the purpose. Mr. Phadke, from Bombay, who has received training in Bacteriology, Pathology and Veterinary Hygiene in Europe has been appointed to the post.

(*c*) The Staff in the Provinces.

The activities of the Agricultural Departments in the various provinces have of necessity been restricted both by the need for economy during the existing financial stress and by the paucity of expert officers. Not only have the services of a considerable number of officers been placed at the disposal of the Military Department but it is at present extremely difficult to obtain any

suitable recruits for the Agricultural Department. Most of the vacant posts could not therefore be filled and the Departments have been much below strength. Experience has shown that for the proper development of agriculture in a province the ideal arrangement is a division of the province into circles representing different agricultural tracts. These circles must be sufficiently small to enable a Deputy Director to get round them frequently and to make himself fully acquainted both with its existing practices and with its future potentialities. At present in most of the provinces Deputy Directors have charge of very large circles representing different agricultural tracts with the result that their activities must be confined to a limited area leaving the rest untouched or if they try to spread their attention over the whole of their charge they make no impression on anything except their health. The reason for this is not far to seek. No agricultural work of any value can be done in a railway train and a great part of an officer's time is of necessity spent in it while getting over his large and scattered circle. What is required is concentration. It simply becomes impossible for the Deputy Directors to direct, over the present scattered areas, with any measure of success, the experimental and demonstration work which is so essential for any material progress. When it becomes possible to divide the provinces into small compact circles, these difficulties will disappear and much more rapid and valuable results will be obtained. The only province which so far has a scheme at all approximating to this ideal is Madras, but it is hoped that it will soon be possible to apply these principles of development throughout India.

The following were the principal changes during the year in the *personnel* of the Provincial Agricultural Departments :—

Bengal. Mr. J. R. Blackwood, I.C.S., was in charge of the Department practically throughout the year. He took long leave in the beginning of June and Mr. Milligan, M.A., B.Sc., the Imperial Agriculturist, was transferred from Pusa to officiate for him. Mr. Hector, the Economic Botanist, proceeded to Europe on 18 months' combined leave from 1st May, 1916. During his leave Mr. Hector proposes to study the more recent developments in plant physiology with special reference

to plant breeding. Mr. Finlow held charge of the botanical work in addition to his own duties.

Bihar and Orissa. Mr. G. Milne, I.C.S., was in charge of the Department till the end of March, when he went on combined leave and Mr. J. R. Dain, I.C.S., succeeded him. With the addition last year of two more Deputy Directors and an Assistant Director all the main agricultural divisions in this province have now been provided with more effective and skilled supervision. An exception is the Tirhoot Division which has no direct supervision by an expert officer, but falls in the charge of the Deputy Director of Agriculture, Patna, who already has a large circle south of the Ganges. A Second Assistant Director has been appointed on probation. Messrs. Woodhouse and McGowan, the Economic Botanist and the Professor of Agriculture, respectively, continued on war service. The latter has been wounded and reverts shortly to civil employ.

United Provinces. The Hon'ble Mr. H. R. C. Hailey, C.I.E., I.C.S., held charge of the Department throughout the year. There was a considerable depletion of the expert staff owing to some having gone on long leave while others had either been transferred or joined the army. Mr. Fremantle, the Principal of the Agricultural College, took long leave and Mr. Leake, the Economic Botanist, had to take charge of the Principalship and to undertake teaching of agriculture in addition to his other work. Mr. Wilson, the Assistant Economic Botanist, was transferred to Madras as Director of the Cinchona Plantations and this caused a serious interference with the botanical research work. Dr. A. E. Parr, the Deputy Director of Agriculture, Western Circle, joined the army in the beginning of the year while Mr. Clarke, the Agricultural Chemist, proceeded on long leave on 7th June, 1916. The shortage of officers was not only felt in the expert staff, but also in the subordinate agricultural service, as an increase in strength must wait on the improvement of financial conditions. A Deputy Director for cattle-breeding has recently been sanctioned.

Punjab. There were no marked changes in the administration of the Department of this province except that Mr. Roberts, the Professor of Agriculture, went on seven months' leave. He is to be on deputation during a part of this leave to study the

organization of agricultural and experimental work in the United States with particular reference to cotton. A post of Entomologist has been sanctioned for five years by the Secretary of State, but steps will be taken to fill the appointment only after financial conditions improve.

Bombay. The Hon'ble Mr. G. F. Keatinge, C.I.E., I.C.S., held charge of the Department throughout the year. There were considerable changes in the expert staff owing to leave vacancies, transfers, etc. Out of the three Deputy Directors, the Department is at present left with the services of only one, Mr. Henderson having been transferred to Pusa as Imperial Agriculturist and Mr. Gilbert having joined the Indian Army Reserve of Officers. Mr. Knight, the Professor of Agriculture, took furlough. Two posts, one of Second Economic Botanist and the other of a Soil Physicist, have been sanctioned, but arrangements to fill them will be made when the financial conditions improve.

Madras. Mr. D. T. Chadwick, I.C.S., held charge of the office of Director of Agriculture till June, 1916, when he went on deputation to Russia and Mr. G. A. D. Stuart, I.C.S., took over charge. The most important event in the administration of the Madras Department of Agriculture was the formulation of a scheme for re-organization and expansion of the Department and its acceptance by the Secretary of State. This scheme provides for nine Deputy Directors to be in charge of distinct agricultural divisions. Of these Deputy Directors of Agriculture one is specially employed in the planting districts consequent upon the handing over to Government of the Scientific Department of the South Indian Planters' Association. Another has been specially recruited for cattle-breeding. Three posts of Deputy Directors are already filled by Messrs. Sampson, Hilson and Thomas and the remaining four will be taken up as time and funds permit. In the meantime the non-gazetted staff has been re-organized and the scheme in regard to them brought into effect.

Mr. Sampson proceeded on leave in October and Mr. Ballard, the Entomologist, who went on medical leave in August, has now joined the Royal Field Artillery.

Up till recently the work connected with machinery required for agricultural purposes and the use of oil engines for well irrigation in this Presidency was in charge of the Director of Industries, but as it was thought that this work together with that of agricultural engineering would be more suitably entrusted to the Agricultural Department, the Local Government sanctioned towards the close of the year an increase in the cadre of the Department in the shape of a post of Agricultural Engineer and a post of Assistant Agricultural Engineer. Henceforth the operations in connection with pumping and boring will, as in most other provinces, be controlled by the Director of Agriculture.

Central Provinces. Mr. C. G. Leftwitch, I.C.S., held charge of the Department throughout the year. There were no material changes in the expert staff. Mr. Plymen returned from long leave in November, and resumed charge of his duties as Agricultural Chemist. Two more posts of Assistant Directors of Agriculture in the cadre of the Indian Agricultural Service were sanctioned during the year, but these will not be filled until provision is made for funds. This sanction brings the total strength of the expert staff for district work to three Deputy Directors and three Assistant Directors.

Assam. Mr. A. R. Edwards, I.C.S., continued to be in charge of the Department of Land Records and Agriculture in this province. Mr. Basu, Additional Deputy Director of Agriculture, retired from the service in May, 1916, and Mr. McKay was appointed to the newly sanctioned post of Second Deputy Director of Agriculture. Mr. Birt continued to be on military service, his circle being entrusted to Mr. Meggitt, the Agricultural Chemist.

Burma. The post of Director of Agriculture was held by Mr. H. Clayton, I.C.S., throughout the year. He was also Joint Registrar of Co-operative Societies. The work in both of these Departments is rapidly increasing and with further expansion on the agricultural side, it will be necessary to relieve the Director of most of the co-operative work so as to enable him effectively to supervise the activities of the Agricultural Department. There was no change in the superior staff except that Mr. Thompstone, Deputy Director of Agriculture, Northern

Circle, proceeded on six months' combined leave in April, 1916 and Mr. Warth, the Agricultural Chemist was placed in charge of the circle in addition to his own duties. The posts of Third Deputy Director of Agriculture and of Economic Botanist were vacant, but in view of the rapid development of work in the Department it will be necessary to fill the latter post soon.

During the year, the full requirements of the province from the view of agricultural development were carefully considered and worked out. The difficulties of communication and the diversity of problems involved necessitate a large increase in the number of Deputy Directors adequately to guide and develop the agriculture of the country. The province can suitably be divided into seven circles each under a Deputy Director. Numerous problems connected with agricultural engineering call for investigation and this points to the necessity of having an Agricultural Engineer also on the staff of the Department.

North-West Frontier Province and Native States. There is no material change to report in the administration of the Department of Agriculture in the North-West Frontier Province or in the Native States of Mysore, Travancore, Baroda and Kashmir. In Central India a new Department is being organized by Mr. B. Coventry who accepted the post of Agricultural Adviser to these States after his retirement from Government service. We look forward to a great development of the Department in these States under the direction of Mr. Coventry. Work in Kashmir is handicapped by the paucity of staff and want of organization. A committee of officials of the State fully considered the question of the maintenance of the Department and its constitution and recommended a policy which has been accepted by His Highness the Maharaja, but its fruition will have to await improved financial conditions.

(*d*) War Services of the Staff.

At the present juncture when the principal efforts of all parts of the British Empire are directed towards fighting the common enemy and each community is undergoing sacrifices in one form or another it is a matter of satisfaction that the Agricultural and Veterinary Departments have responded so well

to the Nation's call. It is true that the development of agricultural and veterinary work has been considerably retarded on account of so many of the officers, both European and Indian, having joined the Army. But this is a small matter compared with the larger issues at stake. In the beginning of July, 1916, a detachment of eight Assistants from Pusa proceeded to Mesopotamia to assist in controlling the flies and vermin which give much trouble to the troops there. Their work has been favourably reported on by the officers under whom they worked. Mr. Sherrard, Deputy Director of Agriculture, Bihar and Orissa, has proceeded to Mesopotamia with a number of *malis* from Government gardens to improve the supply of vegetables and fruit. The greater part of the Agricultural College at Poona has been converted into a War Hospital. Mr. Hewlett, Principal of the Bombay Veterinary College, carried out the duties of Embarkation Officer at Bombay in addition to his civil duties and has been assisted by other officers and students of the college. Mr. Cattell, Superintendent, Civil Veterinary Department, Sind, Rajputana and Baluchistan, undertook in addition to his own duties the control of all equine disease in the military horse-breeding circle in Baluchistan.

In addition to these more special duties a large number of officers of the Departments are assisting the regular military forces in one capacity or another and their names are recorded here as it is but fitting that honour should be done in an official record of the Department's work to those who have voluntarily responded to the call of duty.

Imperial Department of Agriculture in India.

Messrs. J. W. Leather, J. H. Walton, S. N. Mitra, P. G. Patel, H. N. Sharma, L. S. Joseph, P. C. Kar, T. V. V. Subramania Aiyar, P. Narayanam and D. P. Singh.

Imperial Bacteriological Laboratory, Muktesar.

Drs. R. V. Norris and G. H. K. Macalister.

Provincial Departments of Agriculture.

Bengal. Messrs. K. McLean, P. J. Kerr, A. D. MacGregor, Nalinakshya Basu, Nagendra Nath Banerjee, Bidhu Bhusan

Sen, Jitendra Nath Sen Gupta, Khagendra Nath Ghosh, Sailendra Lal Sen and Jagman Singh.

Bihar and Orissa. Messrs. E. J. Woodhouse, N. S. McGowan and G. C. Sherrard.

United Provinces. Dr. A. E. Parr, Messrs. G. Clarke, R. D. Fordham, W. S. Smith, T. S. Davies, M. Sadiq Hussain, Sirdar Jogendra Singh, Sirdar Kehar Singh, Sirdar Murat Singh, Sirdar Niranjan Singh, M. Bashir Mohamed Khan, Sirdar Nand Singh, M. Abdul Rahman, Rai Kedar Nath and Munshi Rahat Husain.

Punjab. Mr. H. Southern.

Bombay. Messrs. T. Gilbert and E. S. Farbrother.

Madras. Messrs. E. Ballard, W. J. D'Costa, S. C. Jeyasingh Raj, S. R. Lakshman and R. Rajamanikkan Pillai.

Central Provinces. Messrs. J. H. Ritchie, L. M. Roy, Abdul Rahman, Hemraj Singh, Atta Mahomed Khan, D. Mulla Singh, M. A. Gafoor Khan, B. S. Pardeshi, Mohan Lal Bali, P. S. Nair, R. K. Patankar, Mirza Kurshed Ali Beg and Qazi Minhazuddin.

Assam. Messrs. A. G. Birt, U. Kollington and Suresh Chandra Chanda.

Burma. Colonel G. H. Evans and Major T. Rannie.

(*e*) Conferences.

An inter-provincial Jute Conference was held at Calcutta under the presidency of Mr. Coventry in August, 1915. It was attended by the Directors of Agriculture and the Scientific Officers of the Agricultural Departments of Bengal, Bihar and Orissa and Assam—the three provinces where the jute crop is of importance. The work already done on this crop was examined and measures for its co-ordination and improvement considered. The recommendations of the Conference are set out in Chapter II of this report.

An informal Conference on the subject of Agricultural Education was held at Pusa in February, 1916, under the presidency of the Hon'ble Mr. C. H. A. Hill, C.S.I., C.I.E., I.C.S. It was composed of officials of the Agricultural and Education Departments, Mr. Fremantle, Collector of Allahabad, the Hon'ble Mr. Lalubhai Samaldass and myself. The resolutions passed have

been referred to Local Governments and will, in due course, be considered by the Government of India.

The ninth meeting of the Board of Agriculture in India was also held at Pusa in February, 1916, and was attended by 47 members and 24 visitors. It was presided over by Mr. Coventry. The arrangements were made by Mr. Wynne Sayer, Assistant to the Agricultural Adviser to the Government of India, who also acted as Secretary to the Board. The principal subjects discussed were (1) soil denudation by rainfall, and drainage, (2) how the energies of the Veterinary Department can best be utilized in the control and check of cattle diseases, (3) the co-operative movement in its relation to agriculture, (4) the Indian sugar industry and (5) cattle breeding and dairying. The proceedings of the Board have been published.

Besides the larger conferences mentioned above some of the Provincial Departments held Provincial Conferences with a view to create public interest in the work of the Department. In some provinces also Departmental Conferences were held: in Burma, officers of the Veterinary and Co-operative services attend such meetings. The value of such conferences lies in the fact that officers of the Department have an opportunity of exchanging their ideas, comparing their experiences and co-ordinating their work. A development of Provincial and Departmental Conferences in which workers interested in economic progress can meet and discuss the lines of advance is much to be desired and should be encouraged.

CHAPTER II.

Progress in Research and Experiment.

(*a*) Agriculture.

It is well known that research and experiment are an essential preliminary to any agricultural improvement. It is also useless to attempt to do any experimental work which is not the outcome of a careful study of local requirements. When these requirements and conditions have been carefully gone into the next point is to apply research and experiment with a view to examine whether any improvement is possible. It is only when satisfactory results are obtained under such conditions and are thoroughly tested, in some cases for a series of years, that they should be presented to the *raiyat* in such a form that he can readily apply them. For research we have founded laboratories and for experiment we have provided agricultural stations spread over various agricultural tracts in each province. In India there is a great variety of climatic and soil conditions and it is necessary that each particular tract should have an experiment station for the solution of the problems arising therein. So far the number has been limited by the amount of expert supervision and trained staff available. In some of the provinces (Madras, Mysore, Baroda) new farms are being opened while in others those that have been recently opened are being equipped and put into working order.

We give a list showing the number of principal agricultural stations in different provinces :—

Bengal	5
Bihar	5
United Provinces	11
Punjab	3
North-West Frontier Province	1
Bombay	17
Madras	10
Central Provinces	7
Assam	5
Burma	6
Mysore	3
Baroda	4

When it is remembered that an agricultural station after it is once laid out takes some years before the land can be brought into uniform condition for making experiments and that experiments themselves take years before they yield definite results, it will be realized that progress in the discovery of any improvement must be slow.

Among the problems facing the Agricultural Department the most urgent is how to increase the outturn of crops in India. This problem is being dealt with in various ways and varying degrees of success have been obtained by the introduction of better varieties, better methods of tillage usually accompanied by the use of improved implements, and irrigation, manuring, etc. It is impossible to describe the various experiments which are being conducted on the experimental stations, but in the following paragraphs an attempt is made to outline the measure of success achieved in some of them.

Wheat. Wheat being the main food crop of the people of Upper India, is naturally most important in the United Provinces and the Punjab. It is also of considerable importance in the North-West Frontier Province and the Central Provinces. A large percentage of the crop (80 to 90 per cent.) is retained in the country for local requirements while the balance is exported, the exports being greatly influenced by the world's supply and the world's prices. The expansion of cultivation has been very marked during recent years as will be seen from the following figures :—

	acres.
Average 1895-96 to 1899-1900 . . .	22,649,000
Average 1905-06 to 1909-10 . . .	26,565,000
Average 1914-15	32,230,000

During 1915-16 there was a fall of about 2 million acres.

As stated above, wheat is not only consumed in this country but is also an article of export. Hence the problems regarding its improvement have been investigated on lines bearing both on the local requirements and the export market. The well-known Pusa 12 satisfies these conditions and the experience of the past four years has shown that it will do admirably in the United Provinces, Bihar and some parts of the Central Provinces. A great point in favour of Pusa 12 is that apart from its qualities

of yield it requires less water than the best local varieties. In the United Provinces where various crop cutting experiments were carried out during the year, on a single irrigation the yield of Pusa wheat was 17 maunds as compared to 14¼ maunds from the local varieties. As far as yields of grain and *bhusa* are concerned, the increased production due to Pusa 12 comes to over Rs. 12 per acre. Vigorous efforts are therefore being made to replace the country wheats in the United Provinces by Pusa 12, and the aid of the co-operative movement, Court of Wards estates and large zamindars is being enlisted.

Another variety of Pusa wheat which is in large demand is No. 4, which owing to its rapidly maturing quality has been found suitable to the wheat-growing tracts where the season is a short one. The demand for seed is increasing and it is being taken up by cultivators. Large quantities of surplus stock of both of these wheats were shipped to England for exhaustive tests by English millers.

While Pusa wheats are making progress, workers in the provinces have not been idle. Varietal tests have been carried out on a considerable scale for many years at Lyallpur. In a great majority of the tests, Punjab 11 proved to be the best under ordinary conditions, and it is being pushed forward in the canal colonies for growing under irrigation. For dry lands, experiments to test the best type of wheat and the best methods of cultivation are in progress at Gurdaspur. In the Southern Circle of the Central Provinces a comparison of the local and introduced varieties during the past five years has shown that Pusa 12 and one variety from Hoshangabad are the best yielders under irrigation and the seed of these is being distributed in the area commanded by new irrigation canals. In the Northern Circle locally selected varieties have given better results and are being introduced on a large scale. In Northern Burma where there is a possible opening for wheat cultivation in place of paddy, experiments have been started to discover the best time and methods of cultivation. The area in this province under wheat rose from 29,000 acres in 1914-15 to 41,000 acres during the year under report.

While the work of selection goes on continuously on the experimental farms dealing with the evolution of superior types

which will take the place of those now being introduced, the question of methods of cultivation is not neglected. There is no doubt that the lands in the wheat-growing tracts are capable of producing a far greater yield if better methods are resorted to and here our attention is arrested by the obvious improvements which can be suggested with *raiyats'* methods of watering their crop. The results of Mr. Howard's work at Quetta referred to in the section under Botany show that it is possible to grow a good crop of wheat with one irrigation given before sowing the seed and with subsequent harrowing and clean cultivation. Experiments have already been undertaken in the Punjab and the Central Provinces and will no doubt prove of value in solving this important problem.

Rice. The importance of this crop in Indian agriculture will be evident from the fact that it is the staple food of the Eastern Provinces, Burma and Southern India. Nearly 35 per cent. of the total cultivated area of India is under rice. In Assam, it occupies nearly 80 per cent. of the cultivated land, in Burma 74 per cent., in Bengal 70 per cent., and in Madras 30 per cent. The area has expanded gradually from 54 million acres in 1904-05 to 76 million acres. India occupies a very prominent position in the world's production of rice and she is the largest exporter although the exports amount to only about 9 per cent. of the total production, the remainder being consumed within the country. In connection with this crop, therefore, the problems of improvement mostly centre round increasing the yield and by that means the local food supply. It is only in Burma, which contributes three quarters of the total Indian exports that the problems of improvement are more complicated. The demand for the crop there is of a special nature, being partly determined by the rice mills and the special markets for which they cater, and partly by local conditions. Some progress has already been made in selecting types suitable for the European markets. They have been pronounced eminently suitable by the mills and the multiplication of seed has been taken in hand. About 110 tons of selected seed was distributed from the Hmawbi Experiment Station during the year under report.

In other provinces the work of improvement consists in the selection and propagation of improved seed. Almost all of them can now claim to possess varieties superior in yielding power to those grown in particular localities and these are being distributed with the object of displacing the local rices. But perhaps the greatest advance made is in the methods of cultivation. Economical transplantation of seedlings has lowered the seed rate and the use of suitable manures has enabled larger outturns to be obtained. The present indications are that the use of green manures, oilcakes and bone-meal will spread. The Department is helping the movement by the distribution of seed of green-manuring crops, starting manure depôts and so on. In the Madras Presidency about 170,000 lb. seed of green manure crops were distributed during the year under report. In the Central Provinces the method of transplanting paddy seedlings is being steadily pushed in areas where it is yet unknown. The average increased yield of the transplanted rice over the ordinary broadcasted rice is 400 to 500 lbs. per acre which, when one realises the acreage under rice in that part, indicates the economic value of the improvement advocated by the Department.

Cotton. Of the total cultivated area of India proper over 6 per cent. is under cotton and within the last 20 years the area has increased by over 67 per cent. The exports of raw cotton (in 1913-14) before the outbreak of war were estimated to be worth more than 27 million pounds sterling. The war has caused a temporary diminution of interest in this crop and the area has fallen off from 24½ million acres in 1914-15 to 18 million acres in 1915-16, a reduction of about 27 per cent.

The crop is receiving a large share of the attention of the Agricultural Departments in Bombay, the Central Provinces, Madras, the Punjab, and the United Provinces, which represent 26, 19, 10, 7 and 5 per cent., respectively of the total area under cotton in India. Both long and short staple cottons are found in India but the area under short staples is by far the larger.

The improvement of this crop in India consists not merely in improving the quality of cotton, *i.e.*, in increasing the length of its staple though this side of the work is also not unimport-

ant, but largely in increasing the amount of outturn and the ginning percentage thereby making the crop more paying to the *raiyat*. The cultivator disposes of his produce as *kapas* or seed cotton and the purchaser fixes the price based very largely upon the amount of lint obtained from that *kapas*. It will thus be realized that the controlling factor in the price obtained by the cultivator is (1) the actual yield of *kapas* and (2) the percentage of lint in the *kapas*. The short staple cottons are generally characterized by high yield and high ginning percentage with the result that cultivators find them more profitable than long staple cottons in which the percentage is generally low. Moreover, they are more hardy and less susceptible to seasonal vicissitudes. These are the reasons which have led the Agricultural Departments to concentrate their efforts principally on short staple cottons in the Central Provinces, in the western districts of the United Provinces and in Khandesh. In the Central Provinces it has been proved by experiments carried over for the last eight years that *roseum* (a type selected from the mixture of local cottons) on account of its high ginning percentage gives on an average more than twice as much lint as Bani (a long staple variety formerly grown in certain parts) and 40 lb. more than the local mixture known as Jari, and consequently its value per acre is worth Rs. 22 more than Bani and Rs. 10 more than Jari. The selection has therefore found favour with the cultivators and with an efficient organization created by the Department for the raising and distribution of seed, nearly $\frac{1}{3}$ of the total area under cotton in Berar has been brought under this variety.

In the western parts of the United Provinces a similar selection made from a mixture of local cottons is becoming popular. Experiments on the Muttra Farm last year resulted in a yield of 400 lb. of lint per acre. The selected variety is not only a heavy yielder but has a high ginning percentage and from the cultivator's point of view is a more profitable crop than ordinary local cotton. Similarly in Khandesh a selection of *roseum* has found favour with cultivators and nearly 200,000 lb. of pure seed were raised and distributed during the past season. In Burma where the cottons are generally characterized by short staple, strains have been selected on experi-

ment stations mainly for the ginning percentage and the best of them shows a gain of between 5 and 6 per cent. over the unselected crop. Seed of the best of these strains will be available for distribution next year.

With regard to long staple cottons it may be mentioned that indigenous long staple cottons have already been grown for a long time past in certain suitable tracts, *e.g.*, Broach cotton in Gujarat and Tinnevellies in South India, and the work of the Agricultural Departments with regard to these consists in improving the strains by selection. In Gujarat some selected strains of the local cotton are being pushed forward in the Surat District. About 1,500 acres were sown with the improved strains during the year under report and the increased price obtained from the produce amounted to Rs. 2-8 per acre. As the price of cotton fluctuates constantly this gain is not likely to be very attractive and the Department is aiming at increasing the margin of profit by a continuous process of seed selection. One of the various selections on an experimental farm already gives promise of proving worth 20 per cent. more than local cotton both on account of its superior quality and ginning percentage. Attempts are also being made to introduce Broach cotton into the Southern Maratha Country to replace the local cotton which is inferior in quality and in some parts it is fairly established though only as yet on a small scale. In both of these localities, auction sales were organized by the Department in order to help the cultivators to get an adequate value for their improved cottons.

In Madras, improved strains of " Tinni " cotton are beginning to produce a marked change in the Tinnevelly District. These are known by the name of " company No. 2 " and " company No. 3." Their superiority over ordinary local cotton in point of purity and length and strength of staple has been proved by several experiments, and the improved cottons during the year under report entered a stage (27,000 acres) at which they could be marketed on a commercial scale. They fetched up to Rs. 16 a candy (500 lb.) more than ordinary country cotton. The percentage of lint of these cottons varies between 28 and 33 as against 25 of ordinary country cotton. Selection of pure strains of local cotton is continuing on Government farms and

it is possible that better strains than the present ones will be obtained from this work.

Mr. Leake's work on cotton in the United Provinces chiefly consists in raising a plant that combines earliness with length of staple and a fair yielding power. His investigations have shown that fine cottons can have only a moderate ginning percentage. By selection he has isolated a type which promises to be an advance on the local variety in certain tracts; and by breeding, a number of races have been raised, some of which show combinations sufficiently promising to be put out on field trials. One hybrid known as K.22 possesses the characteristics of ordinary *deshi* but has a better lint, the value obtained for it being six rupees per maund more than the *deshi*.

With regard to exotic cottons, their cultivation is not likely to extend beyond the limits of irrigation. In Sind, Punjab (Canal Colonies), some parts of the United Provinces, Madras and Bombay their cultivation is extending. In Sind the results of experiments for the last three years have shown that American cotton of the Triumph variety can be grown there without deterioration. A bale of this cotton grown from seed acclimatized for three years was valued at Manchester in April last at 8·20*d*. when middling American stood at 7·90*d*. Although the produce of the American cotton is estimated to be less than the local Sindi cotton, yet owing to the superior quality of the former a premium of 40 per cent. can easily be obtained for it. The American crop in Sind in 1915-16 amounted to 560 bales but owing to a serious admixture with Sindi cotton, its value was considerably reduced and the cultivators could get a premium of only 10 per cent. over Sindi cotton. The Sind Cotton Growing Syndicate is to resume its buying operations next year and if the margin between the value of long and short staple cottons remains adequate and the cultivators can be induced to bring in the American cotton unmixed, there seems no doubt as to the successful future before this cotton in Sind.

In the Canal Colonies of the Punjab, an American variety locally known as 4-F., one of Mr. Milne's selections, is being taken up on a very large scale as its suitability to the Canal Colonies has been proved beyond doubt. About 7,000 acres were grown with it in 1915 and in the auction sale arranged by the

Department, it fetched a premium of from Rs. 2-8 to Rs. 4 per maund over country cotton according to the proportion of country cotton mixed with it. In 1916 about 50,000 acres have been sown with it. The Department is giving every help in supervising this large area as the American cotton calls for better cultivation than country cotton and the price is reduced if country cotton is mixed with it.

In the United Provinces there is a probability of the area under Cawnpore American (an acclimatized variety) being extended in suitable parts where irrigation is available. The market for it has been established and the prices obtained are generally profitable to growers. But a serious set-back at present is the shortage of water in the canals owing to which sowings in the current season (1916) were greatly restricted. If water can be provided at sowing time, larger quantities of this cotton can be made available although the area where it can be grown is comparatively limited.

Last but not the least we come to Cambodia Cotton which has already proved the most successful introduction of recent years. It is grown both in the Bombay and Madras Presidencies, but the area in the latter went up so rapidly owing to the profitable nature of this crop that the development soon got beyond the powers of control of the Agricultural Department. From a small beginning in 1904 the quantity now available is estimated to be 100,000 *candies* (of 500 lb.) annually. Not only have unsuitable lands been cultivated with this crop but the lint also is mixed with inferior kinds and is passed off under the name of Cambodia. This has resulted in a general deterioration of the cotton. The Department has taken up work on this crop with a view to systematically replacing the ordinary Cambodia as now grown with suitable types which are being isolated on the Government farms.

The problem of cotton improvement does not rest with the evolution of suitable or improved types. The question of establishing these improvements in the various tracts is more complicated and difficult. In the first place the seed supply must be kept under control as owing to various causes cotton seed is liable to be mixed and the work of improvement thereby rendered nugatory. Further, when any improvement in quality has

been effected, arrangements must be made in the initial stages to enable the growers to get an adequate price and this must be continued until such time as the market for it is established. The Department is doing its best to help the industry by maintaining a pure seed supply and by assisting cultivators in the ginning, handling and marketing of their produce. The means adopted are described in detail in the chapter on Demonstration. These efforts together with the work on improvement of types which will be continuously going on on the experiment farms have the greatest potentialities, but it rests more with the trade to help forward the movement especially by paying a fair price for improved quality and by frustrating the malpractices of mixing good and bad cottons. It is unnecessary to point out that this bad practice of mixing good and bad cottons although it may pay in the beginning, not only ultimately reduces the value of the improved quality but also upsets the whole work of improvement. The trade alone can remedy this and in this connection we note with pleasure the fine spirit of co-operation displayed by the industry in Madras in putting down this most harmful practice in the case of Tinnevelly cotton mixed with *Pulichai*. We give in some detail the methods successfully employed and commend this example to other provinces.

A low grade variety of cotton locally known as *Pulichai* was introduced some years ago into the Tinnevelly tract and complaints were received from the buying firms that it was being mixed with Tinni cotton with a view to making a profit by selling the mixed lot at Tinni prices. The cultivation of this cotton was increasing and it was feared that the Tinnevelly cotton would lose its reputation by the increasing amount of admixture. The co-operation of the trade was therefore invited. The buying firms gladly decided not to buy *Pulichai* cotton either pure or mixed and the department with the help of Revenue Officers disssuaded cultivators from growing the low grade cotton. These efforts were successful. As no market could be found for *Pulichai* the very name of it became anathema to the brokers. The experiment was most successful and it is hoped that by continuing it for some years *Pulichai* cotton will be eradicated from the Tinnevelly tract.

One reason why India has of late attracted a good deal of attention in regard to cotton production lies in her capability of relieving the Lancashire Mills to some extent from their dependence for the raw material on foreign countries, and it is believed in some quarters that this can be attained by extending the area and by effecting improvements both in yield and quality. There is no doubt that there are possibilities of great development in this crop under favourable conditions, and the work of the Departments referred to above shows that in course of time there will not only be an increased output but also an improvement in quality. The question of the extension of area, is, however, an economic one. An increase in price will always bring about a corresponding increase in area and every care is necessary to avoid an ultimate heavy slump in price which may seriously discourage the grower who naturally extends his area under cotton at the expense of other crops and in hopes of corresponding better returns. With the increase in prices the area has risen from 16 million acres in 1904 to 25 million acres in 1913. In 1914, the prices ruled very low and the effect was that the area in 1915 decreased by about seven million acres. In 1915 the demand improved a little and the prices rose again with the result that the area in 1916-17 shows so far as figures are available, an increase of $\frac{1}{5}$ million acres. It will thus be seen that the area under this crop is largely governed by the prevailing prices and the profits obtainable, and with perhaps the single exception of jute this crop is more affected by the market rates than any other. For, while of almost any other crop it can safely be said a good crop means a good return—of cotton it may on the other hand mean that the whole crop may be left in the grower's hands owing to influences totally beyond his understanding or control, and this feature makes the increasing areas placed under cotton each year a source of some anxiety to an agricultural population who depend on their land for their food entirely.

Sugarcane. Sugar and sugarcane have of late attracted a good deal of attention in India. The industry has been hit hard by the imports of Java sugar which have increased in 25 years from 70,000 to over 800,000 tons. This has led to a considerable diminution of area in certain provinces. The statistics of

production and imports clearly show that although India is the greatest producer of cane sugar (raw) in the world she cannot meet her own demands. The problem therefore has been how to make her self-supporting and this is what the Agricultural Departments are attempting to investigate so far as the cultivation of this crop is concerned. The prevailing high prices of sugar have given a boom to the cultivation and the area in 1915-16 was 2,375,000 acres.

A good deal has been written lately on the subject of this industry and two important papers discussing the question from the broader standpoint were published during the year. One was by Dr. Barber in the " Agricultural Journal of India," July 1915, and the other by Mr. Sayer in the issue of the same Journal, dated January, 1916. These two papers together with the one on the world's cane sugar industry by Mr. Clarke published in the July, 1913 number, should be read for a general exposition of the subject.

The cane-growing tracts of India can be divided into two, *viz.*, (1) Peninsular India and (2) the Indo-Gangetic plain. The former is tropical and can grow excellent thick canes, but water is a limiting factor and only 10 per cent. of the total area under sugarcane in British India is grown here. The latter is outside the tropics but accounts for about 90 per cent. of the total area under sugarcane. The canes, however, are very thin and small and of poor quality and there is a possibility of increasing the outturn by the introduction of better varieties and better methods of cultivation. A number of good imported canes have been tried with success and are being introduced not only in Northern, but also in Southern India. The keystone of Java's success in increasing the output of sugar without materially increasing the area seems to lie in the replacement of the diseased canes by more resistant varieties obtained by crossing. There is a hope that in India also there are possibilities in the application of similar methods to improve the kind of cane grown and Dr. Barber is engaged on this work at the Cane-breeding Station, Coimbatore. The raising of new seedlings requires time but the experiments so far as they have gone are very promising and we await the results of his work with interest. In the meantime, varieties which are superior to the local ones are

being introduced. In the United Provinces, J. 33, a cane of medium thickness, which with proper cultivation is capable of giving a considerably higher yield is being pushed forward with great success. The results of many years' experience on agricultural stations in these provinces seem definitely to show that there is a limit to the yield of sucrose from most of the indigenous canes and that the best way of increasing the output of sugar per acre is by better methods of cultivation which give more cane per acre and by the introduction of improved varieties which give more sugar per cane. The new medium cane seems to be satisfactory in this respect. Its yield per acre at the Rosa Factory during the year was between six to seven hundred maunds compared to the average returns of two to three hundred maunds from the ordinary cane grown by cultivators. There are therefore great possibilities for improvement.

From the work being done on this crop in Bombay it is interesting to note that the results of the experiments on the Manjri Farm are distinctly encouraging. The best sugarcane crop on this farm during 1915-16 amounted to over 50 tons of stripped cane per acre yielding 13,362 lb. of *gur* worth Rs. 954, giving a net profit of Rs. 494. The methods followed at this Station are being introduced into the areas commanded by new canals where the area under sugarcane is increasing rapidly. In the Central Provinces where the area has decreased from 42,000 to 17,000 acres in the past 30 years there are now prospects of the crop recovering its previous position owing to the opening of large areas under the new irrigation works. The Department has succeeded in introducing superior canes from outside the province which are replacing the local variety. Over 8 lakhs of cuttings of these varieties were distributed during the year. Considerable activity is also being displayed in the spread of new varieties in Malabar, South Canara, Mysore, Bengal, Bihar and Assam.

We may now review briefly what progress has been made in the matter of sugar making. On the manufacturing side a good deal has been done in the spread of improved methods of *gur*-making, economical furances and more efficient crushers. The plant designed by Mr. Hulme for dealing with both sugar and

gur on the smallest commercial scale was worked during the year, but it requires further trials before any definte opinion can be pronounced on it. The sugar factories in Bihar had a successful working season last year owing to the high price of sugar, although the yield of sugar from cane was not satisfactory owing to drought. The placing of the 10 per cent. customs duty on imported sugar without any countervailing excise duty is a form of State aid which should help the establishment of central factories in suitable parts of India. As there is a possibility of some large tracts of waste land in Assam proving suitable for sugar growing and for the establishment of central factories, the local department has opened a special sugarcane farm at Kamrup where considerable progress has already been made. As the shortage of labour in Assam is well known, labour-saving machinery will be essential if large sugar estates are to work successfully. Accordingly the Department is working the Farm with steam tackle. Three hundred and seventy-five acres have been reclaimed of which 270 are under cane. Experience has shown the necessity of drainage for successful cane cultivation in the tract. The experiment seems promising but the project requires time before we can definitely say whether these tracts can be utilized for the establishment of big sugar-making concerns. In Burma, conditions for cane growing are excellent in the Môn Canal area where a yield of 30 tons of cane was obtained per acre on an experiment station last year. The crop is yet in the demonstration stage, but the prospects are very promising.

The establishment of central factories is likely to be successful in the south-eastern parts of the United Provinces, *e.g.*, the Gorakhpore Division, and in Bihar and Assam. In other parts the price of *gur* being high and the cultivation of cane being scattered there seems to be little likelihood of such factories being established on a paying basis.

Jute. Of the fibre crops of India jute is by far the most important both on account of the strong commercial demand and the profitableness of its cultivation. India has at present a monopoly in this crop and, within India, the cultivation is practically confined to Bengal and Assam where, on an average, three million acres are annually devoted to it. Part of it is

exported as raw jute while the remainder, apart from the amount consumed locally, is manufactured in India and exported as gunnies and cloth. On an average of the last five years about 720,000 tons or four million bales, worth about 14 million pounds sterling, are annually exported, but if we include the manufactured articles also the total value of jute exports comes to about 29 million pounds sterling. Of late, the supply of this fibre has fallen short of the demand and with a view to increasing the output a conference of officials of the Departments of Agriculture in Bengal, Assam and Bihar and Orissa was held at Calcutta to examine what has been done and to suggest measures for improvement. The Conference was of opinion that there is ample room for increasing the output by effecting improvements in the methods of cultivation and by growing a crop raised from pure line selection. This opinion is being confirmed by the results obtained by Mr. Finlow, Fibre Expert to the Government of Bengal, with manurial experiments and improved seed. Experiments carried on for three successive years at the Dacca Farm which has a red soil have shown that an application of slaked lime and phosphate to these soils produces a marked effect on jute, an increased net return of Rs. 29 per acre being obtained. These results were confirmed during the year under report not only on the farm but on the cultivators' plots in the neighbourhood where an increase of $6\frac{1}{4}$ maunds of jute per acre was obtained in addition to a *rabi* crop obtained off the limed plot which was *all clear profit*. It seems probable that these manures can profitably be taken up on a large scale in red-soil tracts. Experiments with potash manures on this soil also showed striking effects and various neutral salts of potash which are cheaper than pure carbonate of potash are being tested. In West Bengal, Mr. Smith has obtained excellent economic results on jute by the application of either castor cake, superphosphate and sulphate of ammonia or nitrate of soda. Experience has therefore definitely shown that jute responds readily to manuring, and, as its quick growth and bulk demand plenty of nourishment, there is a great scope for increasing the output by the application of suitable manures.

With regard to improved seed, Mr. Finlow has selected from pure line cultures a type (*Kakya Bombai* No. 7) which, as a

result of many trials, leaves no doubt as to its heavier yielding powers than those of the local varieties grown in some districts. Arrangements are being made to distribute it on a large scale, and at the same time experiments are being continued to see if any further improvement is possible. It is calculated that if the departmental seed were universally grown in the jute tracts there would be an increased average yield of 1½ maunds per acre or say 9 lakhs of bales per annum. Arrangements are being made for the production of seed on a large scale on suitable dry lands. The organization of a seed supply is an important problem which is engaging the attention of the Bengal Department. A very gratifying feature is the co-operation of Calcutta jute firms in district field work. Many of them have given plots of land where the improved varieties are grown and tested and I have been much impressed by the very active interest which all sections of the industry take in the experimental work which is being done for the improvement of the crop.

Indigo. Owing to the removal for the time being of the competition of the synthetic product on account of the war, the prices of natural indigo have gone up with a rush and brought about a considerable revival of the industry in Bihar, Madras and the United Provinces where the old factories have been repaired and a considerable area put under the crop. The total area increased from 148,000 in 1914-15 to 314,300 during the year under report. This year the area has further increased to over 600,000 acres. In the United Provinces and Madras, the interest created is at present only temporary. Consequently the efforts made by the Departments in these provinces were in the direction of making a stock of pure seed available for growers. But in Bihar where the industry is of more importance, Mr. and Mrs. Howard continued their investigations into the conditions necessary for the successful growth of the Java plant. They report that the monsoon of 1915 furnished further confirmation of the necessity of soil aeration for the development of the plant, and experiments have been started to determine whether by special treatment and by suitable methods of cultivation lands in Bihar can be made to produce good seed in wet years.

The possibility of improvement on the manufacturing side is discussed later on under the sections on Agricultural Chemistry and Bacteriology.

Tobacco. It has not so far been possible to give this crop much attention owing to the available staff having been engaged on more important crops. The varieties of tobacco commonly grown are coarse but they seem to meet the local taste. Improvements are however possible in the quality of the crop and in methods of curing and manufacture. The most pressing problem in regard to this crop is to oust the foreign cigarette (the imports of which in 1913-14 amounted to a value of nearly 58½ lakhs of rupees) by producing tobacco suitable for this purpose as well as to increase the outturn of genuine Indian cigars principally by providing a better outer leaf or wrapper of finer tobacco. With this object in view work has been taken in hand in Bombay and Bengal where efforts are being made to establish exotics. In Bengal, the results of growing Sumatra tobacco for cigar wrappers are promising and, as the financial return from this variety is much greater than from local varieties, the experiment may prove of value provided there is a sufficient demand for a large quantity.

In the matter, however, of producing a type suitable for cigarette manufacture, a great advance has been made as a result of Mrs. Howard's work at Pusa. The type 28 selected some years ago is being favourably reported on by the trade as suitable for cigarettes. It was tried during the year under report in Burma against other varieties and was valued as the best sample by the principal tobacco firms in Rangoon. In Bihar, the type is gaining favour among cultivators from whom the demand for its seed is annually increasing. Promising results have also been obtained with this type in the United Provinces where distribution of its seed is contemplated in some districts.

The cultivation of the plant has also been studied at Pusa and it has been found that an application of sunn hemp combined with efficient drainage produces the best results, a crop of 24 maunds of cured cigarette tobacco of the value of Rs. 360 per acre having been obtained in this manner. The application of green manures has also been found successful in Bengal and

the practice, when generally adopted, cannot fail to add to the crop outturn.

Along with the growing of varieties, the question of curing and fermentation is also receiving attention, but there are many problems on the manufacturing side which can only be handled by an expert skilled in the chemical and manufacturing aspects of the subject.

Oil-seeds. The Indian export trade in oil-seeds and vegetable oils is worth annually over 16½ million pounds sterling. Only about one-third of the output is exported and the remainder is used in the country, the local consumption of oil both for cooking and toilet purposes being enormous. After the outbreak of war the exports of oil-seeds have naturally declined. This with the resulting low prices has affected the acreage but the trade in oils has on the other hand shown signs of improvement. Although the crops offer a large field for improvement, it has not been possible yet to devote to them any large measure of attention. The oil-seeds that have attracted notice at present are groundnut, sesamum and coconut.

There has been an extraordinary expansion of groundnut cultivation in India within recent years due to the successful introduction of the crop in new localities. The introduction of foreign varieties which give larger yields and are not susceptible to disease has also helped the expansion. The area increased from 431,000 (average of 1900-01 to 1904-05) to 2,413,000 acres in 1914-15. There was a reduction of 20 per cent. during the year under review owing to a variety of causes. The figures relate only to Bombay, Madras and Burma where the crop is grown on an extensive scale. The testing of different varieties goes on at experiment stations and the possibilities of introducing the crop in new localities are being investigated. In Burma the crop is of only recent introduction. From a small beginning in 1902, it now occupies 262 thousand acres and there are signs that its cultivation will expand in new areas as a result of trials on experiment stations. On light sandy soil of the Hopin Experiment Station it gave very good yields during the last two years and the crop seems likely to be taken up by cultivators in that tract as the net profit per

acre from its cultivation has been estimated to be Rs. 47 as against Rs. 12 per acre from paddy.

Of the total area under groundnut in the three provinces named above Madras Presidency alone accounts for about 75 per cent. and as it has also the largest share in the export trade in this commodity the Department has naturally paid considerable attention to this crop. There is a special experiment station where 13 different varieties are being tested for yield of nuts and oil and the best methods of cultivation are being studied.

The crop has also been introduced in Mysore, the United Provinces and the Central Provinces. It is mainly grown here for eating purposes, but as it does well even on light and poor soil and is a good crop for rotation it is readily taken up by cultivators when its suitability to a particular area is demonstrated.

With regard to sesamum, a preliminary classification of the varieties has been undertaken in Burma where the crop covers something like a million acres annually. The oil is largely used in cooking, while the cake is utilized for feeding cattle. About 145 single plant cultures were made during the year under review at the Tatkon Agricultural Station and are being tested with a view to further selection for yield, earliness, quality of seed, etc. In the Central Provinces, a variety was selected some years ago on the Hoshangabad Farm the profits from which are Rs. 4 to 5 per acre more than those from the local variety. Its seed is being distributed from seed farms and about 23,000 acres were sown with it by the cultivators in the tract during the year under review.

As regards coconut, this industry is most important in Malabar and Travancore where the finest quality *copra* is produced and a very large trade has recently sprung up in the export of *copra* for the manufacture of vegetable butter. The importance of the coconut palm tree in South India may be gauged from the fact that the value of exports of its various products during 1914-15, amounted to over one and a half million pounds sterling. The trade has suffered owing to the war and the exports during 1915-16 declined by more than 50 per cent. As the industry is capable of extension and offers

great possibilities for improvement, the Madras Department of Agriculture opened during the year under review three special experiment stations for the study of this crop. In the Travancore State, different varieties are being tested but the trees have not yet borne fruits. Manurial experiments have given very promising results in this State and the advantages of proper manuring are being largely demonstrated. A mixture of 10 lb. oil-cake, 20 lb. ash, 2 lb. bone-meal and 1 lb. salt every year has increased the yield of 10 trees on the experimental farm from 44 nuts in the first year to 919 in the seventh year. Similar results have also been obtained by manuring at the Coimbatore Agricultural Station.

Tea, Coffee and Rubber. These form the "Planters'" crops as they require capital in their cultivation and marketing. The tea industry is most important in Assam as nearly 85 per cent. of the total area under it in India lies in Assam and in the two contiguous districts of Darjeeling and Jalpaiguri. The elevated region over the Malabar coast in South India including Travancore State, contains over 10 per cent. of the total. The investigations of scientific problems concerning tea are in the hands of the Indian Tea Association which receives a subsidy from Government and maintains a Scientific Department with an experiment station. The Industry has been very prosperous during recent years and the year under review was characterised by a large outturn coupled with remarkably high prices. The area (636,000 acres) increased by 2 per cent. while the production (371 million lb.) increased by 19 per cent. as compared to 1914-15. The Scientific Department of the Association continues to do very good work in connection with the study of soils, fungus diseases and insect pests, methods of manuring, pruning and plucking. The effect of various manures on the quality and yield is being demonstrated. Green-manuring is coming into favour and varieties of green-manuring crops together with artificial manures suitable for their growth are being tested. The gradual but marked increase in the production of tea is a good testimony to the results of the labours of the Scientific Department. It is noticeable that while the area under cultivation has increased by 20 per cent. within the last 10 years, the increase in production has

been 55 per cent. Naturally, with the increase in output, the exports of tea have also increased from 260 million lb. in 1911-12 to 338 million lb. in 1915-16.

With regard to coffee and rubber, these industries are confined mainly to South India and Burma, but do not enjoy the same prosperity as tea. In South India, the problems connected with the improvement of these crops were formerly in the hands of the Planters' Association, who had a Scientific Officer. The work has now been transferred to the Madras Department of Agriculture and with the establishment of experiment stations for these crops the various problems will receive due attention. In the meantime, the Scientific Officer has obtained valuable information on the manuring of these crops, and an increasing amount of advice is being given to planters as to the best system of manuring. In co-operation with Dr. Coleman, Director of Agriculture, Mysore, and Mr. McRae, Mycologist to the Madras Government, a considerable amount of work has been done on the various fungoid diseases and insect pests.

Improvements in existing agricultural practices, manuring and implements. The existing agricultural practices of India are based on the accumulated experience of years and improvements can only be suggested after thoroughly testing the advantages or otherwise of the so-called "improved" as against the "prevailing" methods. Experiments are constantly being carried out on the agricultural stations to test the best methods of cultivation, rotation, and application of manures suited to particular tracts and, in some cases, where the methods of cultivators are primitive, the advantages of improved methods have at once been apparent and they are being vigorously pursued. A noticeable example of this is the introduction of drill sowing of cotton in the Tinnevelly district of the Madras Presidency and that of transplantation of rice in the Chhattisgarh division of the Central Provinces. The area in the Tinnevelly district under drilled cotton rose from 1,500 acres in 1910 to 17,000 acres in 1915-16. The advantages of this method are so obvious that in order to meet the demands of the cultivators, labourers are being trained in the use of the drills and harrows and employed to teach others in their own and

adjoining villages. Transplantation of rice in Chhatisgarh is one of the most firmly established successes of the Department and experiments continue to prove the very great advantage to be derived from transplantation, which not only increases the outturn but actually involves less cost in cultivation owing to the absence of any need for weeding. A further reform in the method of rice cultivation is the reduction of the seed-rate, especially in South India.

Another improvement not so directly visible is the introduction of iron ploughs. The use of these ploughs has now gone beyond the experimental stage and their sale is run as a business proposition. The extent to which they are used is shown by the fact that in some tracts in Bombay Presidency, you cannot now find a wooden plough. The sale of these implements from some of the farms and depôts alone in this Presidency amounted to about Rs. 70,000.

With regard to manures, experiments have demonstrated the possibility of an economical use of some of the artificial manures on certain crops in particular localities, but being expensive their use is at present limited. The greatest success has been achieved in the use of manures which are obtainable locally (*i.e.*, oil-cakes, bone-meal and green manures), and the demonstration of the advantages following their use now forms an important part of the departmental programme. A very useful paper describing the theory and practice of green-manuring was published by Mr. Dobbs during the year as Pusa Bulletin No. 56. Another important paper on the same subject was that of Mr. Hutchinson published as Pusa Bulletin No. 63. It deals with a modified method of green-manuring and is reviewed in detail in the section on Agricultural Bacteriology. In Madras, Bengal and Assam, the practice of green manuring paddy fields continued to spread, while in the Planting Districts as many as 40 different green-manuring plants were tested as to their comparative value on tea estates.

(*b*) Agricultural Chemistry.

There are various factors underlying the successful growth of crops and agricultural chemistry concerns itself with the

investigation and control of some of them. Soil and water are the chief requirements in the vegetable kingdom and Agricultural Chemists have naturally been primarily concerned with the investigation of various problems connected with these though other secondary problems such as the chemistry of sugar-cane, composition of various feeding stuffs, etc., are also receiving attention. It is impossible to describe in a report like this the details of all the scientific work which is being done, but in the following paragraphs a brief account of the more important investigations which have been completed or which are in progress is attempted.

Soils. A survey of the soils of the Guntur Delta was completed by Dr. Harrison in Madras and the results were published in a Departmental bulletin. The nitrogen content of these soils has been found to be low which points to the necessity of special manurial methods to rectify this defect. The enquiry demonstrated the great effect of river silt in modifying the manurial character of the soil of the Delta. The silt of the Kistna river is rich in certain constituents and the soil under its influence materially differs from the poorer soils of the coast and in the centre of the Delta. These facts furnish a strong argument in favour of conserving the silt of the Kistna river.

Mr. Warth in Burma is engaged on the examination of certain typical paddy soils, the special point at present being the determination of total supply and availability of phosphoric acid in them. He is also studying certain types of soil which at times produce very irregular growth of paddy. It has been found that the acidity of these soils is liable to extraordinary fluctuations and an enquiry into the nature and source of this acidity is in progress.

In the Punjab, Mr. Barnes has obtained very satisfactory results in his experiments on the reclamation of alkali soils by deep cultivation, draining and washing. He has shown that for a sum of Rs. 18 per acre plus a charge as yet undecided for additional water, it should be possible to reclaim ordinary *Kallar* (saline) land within the canal colonies. Excellent crops of wheat (the highest yield being 37 maunds per acre) were obtained from the treated land which, previous to this treatment, was entirely barren. The results justify the hope that

the method is likely to prove a commercial success and Mr. Barnes is of opinion that the land so treated will remain in its reclaimed condition for a considerable number of years, if properly cultivated which, of course, is essential.

The work on the study of gases of the swamp paddy soils was continued by Dr. Harrison and two other memoirs in the Chemical Series were published on the subject. It has now been demonstrated that nitrogen gas in paddy soils is derived from organic matter undergoing decomposition in the soils and most of the nitrogen contained in green manures is thus wasted and rendered valueless for manurial purposes. Green manures must not therefore be considered as direct manures but as owing their efficiency mainly to their indirect action on the soil by increasing root aeration. The best cropping results seem to be attained when the use of green manure is supplemented by nitrogenous manures. It has also incidentally been shown that gases produced by the fermentation of organic matter in the paddy soils are trapped and retained in the soils by the mass of fine roots of the crop and are thus conserved and made available for root aeration during the later stages of growth.

A third publication on the same subject was that of Mr. Leather, Imperial Agricultural Chemist, who has directly measured the volume of gas in Pusa soil, under different conditions.

Mr. Meggitt, Agricultural Chemist in Assam, continued his investigations on the improvement of acid soils of Assam. The experiments are still in progress but the results so far definitely prove the vital importance of the use of lime, green manures and phosphoric acid for most crops in these soils.

Feeding Stuffs. As rice forms the chief article of food of a vast population in India, it is but natural that the question of its nutritive value should engage the attention of Agricultural Chemists in rice-growing provinces. A certain amount of work has already been done by Mr. Warth in Burma, in determining whether the desirable morphological, agricultural and dietetic characters are correlated with one another and with environmental conditions so that less desirable qualities and non-essential differences may be eliminated and the rice classified into relatively few grades. During the year under

report Mr. Sen, Officiating Imperial Agricultural Chemist, took up the study of the composition of the Bihar rices, the assimilation of nutrients by the rice plant and the feeding value of the different parts of the plant at various stages of growth. The preliminary results have been published in Pusa Bulletins Nos. 62 and 65. The results recorded in the former Bulletin are of general importance from the point of view of dietetic properties as they definitely show that modern milling and husking processes are robbing rice of much of its nutritive constituents and it is a question whether the consumer really benefits by the polishing and cleaning now done.

Sugarcane. Considerable activity is being displayed in most of the provinces in testing cane varieties under chemical control and in investigating the factors which influence the sugar content of the juice of different varieties. Thus, Mr. Clarke at Sahajahanpur (United Provinces) has been making selections of the best varieties of indigenous and foreign canes to replace the mixed varieties grown in the various sugar tracts of the United Provinces. The immediate result of these investigations has been the recommendation of two varieties as most suitable for the province. Mr. Taylor in Bihar has obtained important results in his researches on the ripening of the different varieties of cane. He has found great differences in the period of ripening of different classes of canes, a matter of great importance to the factories in the tract as it shows a means whereby the milling season may be extended. As a result of examination of the Punjab canes, Mr. Barnes is of opinion that as better canes are to be got in the southern Punjab than in the Gurdaspur district, future work should be confined to the southern districts. In Mysore, in addition to the testing of varieties, the effect produced by the addition of different quantities of lime on colour, hardness, and keeping qualities of jaggery was ascertained.

Date Palm. Mr. Annett continued his investigations on the date-sugar industry in Bengal. He has found that the dark colour of the palm *gur* is due to the palm juices containing potassium bicarbonate. The use of acid products, such as alum, lemon juice, tamarind fruit extract, neutralizes the juice and gives a lovely golden colour to the jaggery. The use of lime in

the collecting pots has been found efficacious in preserving the juice. By this process even the day juice can be boiled down to *gur* and about 20 per cent. more sugar obtained than at present from the same number of trees. Tests made to ascertain the amount of fuel used by cultivators to make a maund of *gur* have shown that there is considerable room for economy by modifying the local furnaces. Experiments in refining the *gur* by means of centrifuges were also attended with success, but it is a question whether the *raiyat* will ever realise the loss he suffers by his wasteful methods which are too ingrained in him to be easily eradicated.

Sugar-Beet. Mr. Barnes has for some years past been making experiments with sugar-beet at Lyallpur and in Kashmir. These yielded encouraging results during the year. Roots containing $14\frac{1}{2}$ per cent. of sucrose were grown at Lyallpur from seed raised in Kashmir and in Kashmir itself roots containing as much as $16\frac{3}{4}$ per cent. of sucrose have been grown. In view of the fact that beet has not been found to seed in the plains of India this demonstration of the possibility of raising seed in the colder climate of Kashmir for use in the Punjab and North-West Frontier Province is very valuable, but whether this will ever have any material effect on the sugar problem is doubtful.

Manures. As regards manures, perhaps the most important work of the year from the cultivator's point of view is that by Dr. Mann in the Bombay Presidency. Details have been published in a Departmental bulletin in which recommendations have been made as to the composition of mixtures of artificial manures suitable for use in different regions of the Presidency for the various crops. The experiments have shown that in most cases artificial manures can only be profitably used where the rainfall is reliable or where facilities for irrigation are available. The advantage in the use of these artificials lies in the fact that results can often be produced more speedily and more cheaply and that, more especially in the case of superphosphate and potash fertilizers, they can be used to supplement the deficiencies of other manures when dealing with certain soils and certain crops.

Another important work which may have very far-reaching consequences is that undertaken by Mr. Finlow, Fibre Expert

to the Government of Bengal, on the water hyacinth (*Eichhornia crassipes*) as a source of potash. Until recently this plant was regarded as a beautiful aquatic flower, but it is now becoming a most serious pest in Bengal and Burma, blocking up streams and impeding navigation. Mr. Finlow has investigated the possible utilization of this plant as a manurial agency and has found that the ash is rich in potash. On account of its high water content it is not possible to use the plant in its green state but if it is rotted or dried, it becomes a valuable manure, containing twice as much nitrogen and four times as much potash as farm-yard manure. It is true that it is not possible to cart this rotted or dried material long distances on account of its bulk, but the fields adjoining the areas can be economically treated with it. The effects produced by this manure on experimental plots at Dacca both in the rotted and dried condition were very marked. If, after drying, the plant is reduced to ashes, the ash contains 45 per cent. of potassium chloride in addition to 4 per cent. of phosphoric acid. It is, therefore, clear that it will abundantly pay the cultivator to use the burnt or rotted hyacinth when it is close to his holding and demonstrations on a large scale are to be organized this season in the affected areas in Bengal. The question of the utilization of ash as a commercial source of potash is also being investigated by Mr. Finlow and here we have one of the clearest cases of a pest becoming of use and value and actually paying for its removal.

Indigo. One of the reasons why synthetic indigo finds favour in the market is the fact that it provides the dyer with an article of standard quality in a form ready for immediate use. Natural indigo on the other hand is usually sold in the form of cakes which require costly machinery and highly trained skill to prepare them for use in the dyeing vats. It will thus be seen why the placing of the natural product on the market in the form of paste is considered one of the essential means of reviving the Indian indigo industry. For a solution of this and other chemical problems the Government of India obtained the sanction of the Secretary of State to the creation of a special appointment of Indigo Research Chemist. Mr. W. A. Davis, who was recruited for this appointment arrived towards the end of May last and in consequence the work he has done up to

date hardly comes within the purview of this report which deals with the period ending 30th June. But it may be mentioned that after preliminary experiments designed to ascertain the best preservative and the conditions of working necessary to obtain a paste of standard quality, he has manufactured about half a ton of indigo paste containing about 18·75 per cent. of indigotin. This has been shipped to England for trials by British dyers and the results will be awaited with interest. There is every hope that it will be possible to manufacture a commercial paste of standard strength but there are at present many points which require further investigation. Moreover it is not known how natural indigo will face the synthetic product when the latter comes again on the market after the cessation of hostilities. It seems, however, probable that natural indigo will be able to hold its own if an increase in the outturn of crop per acre and in the amount of indigo extracted from the plant can be effected, as the cost of the production of natural indigo is small in comparison with that of synthetic. The work of the Howards and researches on some of the points elucidated by Mr. Davis may possibly bring both these improvements within the range of practicability.

(*c*) **Botany.**

The improvement of crops in India is being attempted by Botanists mainly on two lines, *viz.*, (1) improvement by selection and (2) hybridization. The first method consists in isolating and growing in pure culture a desirable type or types out of numerous varieties, while in the latter a combination of the desired characters of two or more types is obtained by cross-breeding or hybridization. The isolation and testing of pure lines produced from a typical selection of a single plant, are however the basis for improvement in both these methods. The task is of no small magnitude when it is remembered that there is an extraordinarily large number of varieties which goes to make up the mixture in almost every crop in India. Further, after a systematic collection of the varieties of each crop has been made, the minute distinction of morphological characters has to be made and the economically significant characters have

to be segregated into specific types for specific purposes. The work of creating new varieties is more laborious and slow and requires an infinity of patience, the difficulty being to isolate the plants which contain within themselves a large number of these desirable characters. On the other hand, selection by pure line breeding is of a simple nature and in many cases therefore mere separation of the various types by pure line cultures has led to great agricultural progress. Good types of various crops have in this way been selected either by Deputy Directors or by Economic Botanists and are being introduced in various provinces pending the evolution of more desirable types as a result of cross-breeding.

We may now proceed to review some of the more important work in economic botany done during the year :—

Wheat. The main work on wheat at Pusa and in the United Provinces was in connection with the replacement in the latter province of local varieties by Pusa 12. As the special qualities of Pusa 12 and Pusa 4 have already been sufficiently described in previous reports it is not necessary to repeat them here. The season during the year under report was characterized by a shortage of moisture but Pusa 12 again behaved in a satisfactory manner, the average yield in many places being considerably more than the *desri* variety. A stage is being reached when it will be possible to see large areas grown with this variety which will enable India to take a considerably larger share in the production of wheat for the Empire. In tracts like Bundelkhand, some of the Central India States, the southern parts of Bombay Presidency and parts of Bihar where a rapidly maturing variety requiring a short supply of moisture is essential, Pusa 4 has given good results and is being taken up by cultivators. 5,000 maunds of Pusa 12 and 4,000 maunds of Pusa 4 were shipped to England at the request of the millers for milling and baking tests of these varieties and their report is awaited.

A useful piece of work concluded by the Howards during the year was in connection with the saving of water as required for irrigating wheat in the Quetta Valley. Experiments continued over three years have proved that a single irrigation before sowing yields much greater outturn than the five or six waterings

usually given by cultivators during the growth of the crop. These results are of great value as indicating the waste of water that is now going on and which is preventable to a large extent. The water so saved can be utilized for irrigating land which at present goes without it.

In the Punjab, the Economic Botanist devoted a considerable portion of his time to the wheat crop. A number of types have been selected and are being grown on a field scale while over 100 crosses are being compared.

Mr. Graham in the Central Provinces has been successful in obtaining a cross between a local wheat and an Australian variety which in a preliminary trial showed complete resistance to rust, (a point which renders it of the greatest value to India), the straw bearing the strong Australian character.

Paddy. This important crop is receiving increased attention at the hands of the Botanists in Madras, Bombay, Bengal, and the Central Provinces. A paddy-breeding station has been started at Coimbatore in Madras where innumerable varieties collected from the districts are being grown and their characters studied, the special economic characters under investigation being size and shape of grain, habit of the plant, tillering power, duration of the crop and scent of rice. Investigation of single plant selections of various varieties was continued on a larger scale and the two best selections yielded over 3,200 lb. of paddy per acre.

Mr. Graham in the Central Provinces has succeeded in isolating from his pure cultures, a medium rice combining the two desirable characters of quality and yield. One type (No. 12) is now in considerable demand in the north of the province, while another is rapidly growing in popularity in the south and east. The latter variety owing to its good tillering power requires a low seed rate; besides, the percentage of clean rice to unhusked rice is greater than that of most local varieties, while the actual outturn of paddy also is larger. Its seed is being multiplied on seed farms. Mr. Graham has also taken up a systematic study of the wild rices which are a curse to rice cultivators especially in the rice tract of Chhattisgarh.

In Bengal, Mr. Hector has obtained as a result of selection an outstanding variety which was grown during the year on

the Dacca Farm and on various cultivators' plots in some districts and gave an average increase of eight maunds per acre over the country crop.

In Burma, pending the appointment of a Botanist, the work of selection of the best paddy strains is being done by Deputy Directors on experimental stations. A large number of pure lines are in process of selection and certain improved strains were pronounced by the Burma Chamber of Commerce to be greatly superior to the best paddy at present obtainable by the mills. The work of reproduction of these strains has been taken in hand and large quantities of seed will be available for distribution next year.

Sugarcane. The most important work on sugarcane from the botanical point of view is that of Dr. Barber at the cane-breeding station at Coimbatore. The object of this work is the evolution of new varieties to suit various conditions and localities in India by raising seedling canes. Investigations are being directed to the discovery of correlation between the various visible botanical characters of the canes and the richness of their juices which will have important results on the method of work on the station. Thousands of seedlings have been raised. Considerable progress has also been made in the classification of indigenous Indian canes. An idea of this highly scientific work and its present position can best be obtained from the following passage taken from an account given by Dr. Barber in the Report of the Board of Scientific Advice :—

"The cane-breeding station has now been in existence for three years, and it is possible to form some idea as to the average length of time before a new seedling can, with any degree of safety, be introduced to the cultivators. Owing to the unfortunate fact that seedlings can only be obtained in October—December and that they take 18 months to mature, they are analysed in June—July, which is out of harmony with the local ripening season (February—March). A year is thus lost in bringing the seedlings into line with local conditions, and only 2 analyses can be made in the first three years. Two further years are considered necessary for determination of habit and vigour and thus it is five years before a seedling can be sent out for testing in the locality for which it is supposed to be suitable. Giving a minimum of two years in the provincial farm before it is possible to recommend the new cane to the cultivators, we see that seven years must elapse before

any new introduction can begin to have effect on the cultivators' fields. Some 100,000 seedlings have now been raised, and it is estimated that, of these possibly a dozen new varieties may prove of ultimate value in the field. This works out at something like one in 10,000, a lower proportion than that assumed for Barbados, but considerably higher than the estimate in British Guiana, where only one out of every 26,000 is considered likely to be of use. Considering the special difficulties in the Indian conditions, this result is not regarded as unsatisfactory."

Cotton. Mr. Leake's work in the United Provinces on the improvement of cotton by selection and cross-breeding has reached a stage at which some of the isolated types and crosses have proved promising enough to be tried on a field scale. One type (K. 22), which is a hybrid, shows every prospect of proving a valuable field crop. It is an improvement over the ordinary *deshi* in that it has a better lint (the lint fetching about 20 per cent. more price) with as high a yield and ginning percentage as the *deshi*. In habit also it is the same as *deshi*. This fact makes it suitable for growing in place of the *deshi* variety over wide areas in which the local conditions have up to date rendered the latter the only type which can be satisfactorily grown. A considerable amount of work is being done by Mr. Milne, the Punjab Botanist, in the production of new strains of both American and *deshi* cottons suitable for the province. A number of new strains are being tested and some of them have been valued to be worth Rs. 350 to Rs. 500 per candy of 783 lb. A useful point elucidated in this work during the year was the necessity of avoiding very sandy soils for growing American cottons, owing to a marked inequality in the length and strength of the lint which results if a crop is grown on such soils. *Deshi* cottons are not affected to the same extent.

Fruit. An increasing amount of attention is being paid to the study of fruit trees and plantations. Although the work at present is of a scattered nature, yet it is promising and in most of the provinces, the possibility of various tracts suited to fruit growing is being examined. Manurial, irrigational, cultural, pruning, varietal and such other experiments are in progress Mr. Howard, in addition to other work on the subject, paid considerable attention to the problems relating to packing and transport of fruit from Baluchistan. The various fruit

boxes designed by him are being taken up by fruit dealers, and if railway authorities co-operate in the matter by allowing these packages to be returned free as 'empties' a great advance is likely to be made in the fruit industry of North-West India. Mr. Robertson Brown, in the North-West Frontier Province, has already succeeded in introducing most valuable American and Australian varieties of peaches and plums and has found a suitable stock for the Malta orange.

The success of Arabian date-palms introduced in the Punjab is now no longer a matter of doubt and the question is only to replace the local variety by the introduced one. This is being done. The economic importance of this work will be evident from the fact that, if the introduced variety whose fruits fetch higher prices on account of their superiority in appearance wholly replaces the native variety, it will raise the value of the crop from 17½ lakhs to 70 lakhs of rupees annually. Much activity is being displayed by Dr. Burns and his staff in the improvement of fruit growing in the Bombay Presidency with the result that keen interest is now being shown in this work by the fruit growers and garden owners.

Fodders. The importance of the fodder problem in this country requires no emphasis. The question of the improvement of cattle in any district is bound up with that of the improvement and increase of fodder. This is especially so in view of the diminishing grazing area and the extension of crops like cotton. More attention is being given to this problem in Bombay than elsewhere and a number of articles have been published in various Journals. Various fodder grasses have been investigated and their feeding values ascertained.

Perhaps the most important work in fodder production during the year was that of the Howards, who have demonstrated the possibility of increasing the fodder supplies available in the Quetta Valley, at the same time introducing a green-manuring crop for the improvement of the wheat land. They have shown that by careful cultivation, a considerable amount of *shaftal* (*Trifolium resupinatum*) fodder can be obtained which can be turned into hay by taking certain necessary precautions. For a detailed description, we would

refer the reader to an article on the subject in the Agricultural Journal of India, January, 1916.

Miscellaneous. One important aspect of botanical science is its relation to agriculture and this has clearly been defined by Mr. Howard in his paper read at the last Indian Science Congress and subsequently published in the Congress number of the Agricultural Journal of India. He is of opinion that ordinary agricultural processes applied to any crop bear a direct relationship to the physiological necessities of the plant and for a real progress in plant improvement, the investigator must have a knowledge of these agricultural processes. He must be able to grow his crop to perfection; otherwise some of the characters in a plant are likely to be entirely masked by bad cultivation. A combination of science and practice is therefore required in all agricultural investigations dealing with the plant and, in addition, the investigator must have a knowledge of the requirements of the trade. The work in the Botanical Section at Pusa thus comprises every aspect of the improvement of the staples from the scientific study of the crops to the conditions necessary for the successful growing and raising of selected types. Considerable experience has been obtained in this section in the methods necessary to grow a crop. They point to the great importance of soil aeration for an increase in crop-production. By a practical application of this principle very good crops have been obtained at Pusa and in the neighbourhood. For details a reference should be made to Pusa Bulletin No. 61, in which the connection between soil aeration and the actual growth of crops as well as the development of quality has been outlined and the practical applications of soil ventilation have been considered. A great deal of attention has also been paid in this section to the prevention of soil erosion by surface drainage and the method adopted has been of considerable use in connection with plant-breeding work of the section. Its broader application depends upon the solution of the wider question of natural drainage which is defective in many parts of the alluvial tracts of Northern India. For a full discussion on this subject a reference should be made to the report of the committee appointed at the last meeting of the Board of Agriculture to

deal with this question (printed in the proceedings of the Board) and to Pusa Bulletin No. 53.

(*d*) Mycology.

There are at present five Mycologists working on plant pathology in India, two of whom are located at Pusa, one in Madras, one in Mysore, and one under the Indian Tea Association. But this number is obviously inadequate having regard to the number of plant diseases that call for investigation in so large a country as India. Among the provinces, it is only Madras, as noted above, that has got a trained European Mycologist. In other Provinces, the work is done by trained Indian Assistants under advice and assistance from Pusa.

The most important disease under investigation at Pusa was that known locally as *Ufra* in Eastern Bengal. Estimates of the losses caused by this disease to the paddy crop are difficult to obtain, but an idea of the extent of its ravages can be formed from the fact that in a small portion of the Bhowal Pargana of the Dacca district alone, the destruction caused by this disease is estimated to average over $2\frac{1}{4}$ lakhs of rupees annually. It has now been conclusively proved that the cause of the disease is the microscopic eelworm—*Tylenchus angustus*. This worm hibernates in the stubble which it is the practice in the infected areas to leave on the fields after harvest. It renews its activity with the coming of the floods and the high atmospheric humidity of the rains. It is a semi-aquatic species, perishing in some weeks if wholly immersed in water. On a dry surface it is unable to move unless the humidity of the surrounding air is high but tends to coil itself up into a twisted mass and pass into a dormant condition. It appears to be unable to grow much or moult unless supplied with living paddy plants. The results of several experiments carried out to test whether the worm can remain alive in soil indicate that it cannot survive during the interval between successive crops in this manner. Experiments have also shown that a diseased plot will inevitably give a diseased crop the following season if the stubble is allowed to rot on the ground as is the usual practice in the lower class of land in the eastern

districts of Bengal, but if all the stubble is destroyed a healthy crop can be grown. The problem therefore resolves itself into ascertaining the best way of removing and destroying this stubble and work is in progress in collaboration with the Bengal Department of Agriculture to find out the best way of doing this. Either burning the stubble or ploughing in the debris as soon after the harvest as possible or a combination of both may be found most convenient. The Bengal Department is carrying out demonstrations to impress upon the cultivators the necessity of destroying stubble and is also making trials with early ripening varieties which suffer less than the later kinds.

Work on the parasitic species of *Orobanche*, locally known as *tokras*, which are a source of heavy damage to solanaceous and cruciferous crops in Bihar (*e.g.*, tobacco, mustard, cabbage), was continued at Pusa and experiments were carried out with a view to discovering whether the addition of quantities of sodium nitrate to crops of mustard and tobacco has any influence on the number of *tokras* which occur in these crops. The results so far obtained do not indicate this treatment to be a specific remedy for *tokras*.

Research work on the genus *Rhizoctonia* which has attracted considerable attention in recent years in India and also in foreign countries, was continued by Mr. Shaw, Second Imperial Mycologist. A joint paper on this genus was published during the year as Memoir of the Botanical Series, Vol. VII, No. 4. The paper describes two species of this genus which are of some economic importance and also presents some points of general scientific interest.

Mr. Dastur, First Assistant to the Imperial Mycologist, studied two local plantain diseases and the black thread disease of rubber in Burma. An account of his work on the former has been published in the Agricultural Journal of India for July, 1915, and April, 1916. The black thread disease causes serious damage to Hevea rubber plantations in Burma and also in South India. The fungus is a wound parasite on rubber being unable to infect the undamaged bark. It is favoured by excessive humidity and shade and the chief source of infection seems to be the fruits. Judicious pruning and thinning so as to admit of free sunlight and air as well as destruction of

fruits before the monsoon in infected areas are recommended as likely to give good results. A popular account has been published as a Bulletin of the Burma Department, while more technical information is given in a Memoir of this Department (Botanical Series, Vol. VIII, No. 4).

Among other diseases which are under investigation at Pusa may be mentioned the disease of Sâl trees in the Bengal Duars and wilt diseases of cotton, sesamum, gram and chillies and sclerotial diseases of jute and sugarcane. Besides this a good deal of systematic work (in the way of additions to the herbarium and naming of collections sent by provinces) was done. The fifth part of the series of 'Fungi Indiæ Orientalis' containing determinations of various species of the group of *Deuteromycetes* was published during the year. It is based upon the material sent to Messrs. H. and P. Sydow of Berlin, before the war. Dr. Butler has also completed the manuscript of a book on fungi as a cause of plant disease in India. While on leave he prepared a note for the Royal Horticultural Society on the dissemination of parasitic fungi as a basis for international legislation. This note has since been written up with special reference to Indian problems and is being published as a Memoir of the Department.

Considerable progress was made by Mr. McRae, the Madras Mycologist, Dr. Coleman, the Director of Agriculture, Mysore, and Mr. Anstead, the Deputy Director of Agriculture for Planting Districts, in the eradication of some serious diseases of plantation crops in South India. The new method of dealing with the palmyra palm disease in which every palm in every known centre of disease is examined so as to detect the early stages of the attack and in which the diseased parts of the crown are cut out and burnt, was vigorously pursued in Malabar and the Godavari and Kistna districts. The effect of this treatment is very marked; the number of new infections was considerably reduced as a result of the first year's work in the Kistna district where in the second round only 4 per cent. of the trees examined were found to be diseased or dead. In the Godavari district where the work was taken up for the first time, the percentage of diseased trees was 8. The total number of trees examined during the year in these two districts

was seven lakhs which was possible through the sympathy and co-operation which the *raiyats* evinced in this matter. It is hoped that in a few years as a result of the measures adopted the disease will be completely exterminated.

The *Koleroga* disease of the areca palm continued to receive the attention of Dr. Coleman and also of Mr. McRae. Further work in connection with the control of this disease both in Mysore and Malabar has shown that the disease can be definitely stamped out from isolated areas by means of spraying. Keen interest in the work was taken by garden owners, who purchased a number of sprayers. The progress made in this work is satisfactory having regard to the fact that war has made it difficult to get sprayers and their spare parts. Measures to enforce the treatment are being considered in Mysore, which if adopted will enable the Department to extend the operations to a very large extent. It is interesting to note that this method of spraying is also being introduced in the southern districts of the Bombay Presidency with a view to control the same disease.

Mr. Anstead carried out experiments in collaboration with Dr. Coleman in the treatment of diseases of coffee and a large measure of success was achieved in checking 'black rot' of leaf by spraying with Bordeaux mixture. He also studied with Mr. McRae, the black thread of Hevea rubber and the 'brown blight of tea' and in the latter case spraying with Bordeaux mixture has proved successful in restoring attacked nursery plants to vigour. Dr. Coleman has taken up the study of the "spike disease" of sandal wood and a preliminary report is to be published shortly.

Mr. Kulkarni, the Assistant Mycologist of the Bombay Department, completed a detailed study of the smuts of *Jowar* (sorghum) in Bombay with the result that four distinct smuts in this crop, two of which can be prevented, have been detected. Arrangements have been made by the Bombay Department for the sale of one anna packets of copper sulphate (each sufficient to steep *Jowar* seed for 4 acres) as a preventive against smut. About 40,000 of such packets were sold during the year. If these have been properly used it is calculated that a saving of some three lakhs of rupees must have accrued to the cultivators.

Similar campaigns were also organized against *Jowar* smut in Mysore and the Central Provinces with great success.

Mr. Tunstall, the Mycologist under the Indian Tea Association, continued investigations on the fungi which attack the roots of tea. A pamphlet containing a simple description of the structure and functions of tea roots was published to help planters in the identification of the root parasites. The fungi-causing various leaf diseases on tea were also studied while much attention was devoted to the practical methods of blight treatment. Knapsack sprayers worked on the battery system by compressed air have given the best results, but with a view to make the work more automatic some simpler arrangement is being evolved.

The Economic Botanist in the United Provinces has been investigating the poppy blight and has come to the conclusion that the disease is epidemic only when climatic conditions are favourable and proper drainage is not provided. Improved cultivation and drainage would give best results in minimising the ravages. He has also discovered certain varieties which appear to be almost immune to the disease.

(*e*) Entomology.

India teems with insect life, some useful but the majority not, and though the scope for entomological work in India is unlimited the number of expert entomologists working in this country is at present only 4. Of these, one is located at Pusa, one is in Madras and the remaining two are employed in Mysore and under the Indian Tea Association. The work in all the provinces except Madras is done by trained Indian Assistants under advice and assistance from Pusa. The more important investigations carried out during the year on various insect pests were as follows :—

Cotton Pests. Experiments were continued at Pusa to test the relative immunity to bollworm attack of different varieties of cotton from various provinces and a study was made of the hibernation and alternative hosts of the parasites that emerged. It was found that there are at least 5 different species of the parasite (Rhogas) which attack cotton bollworms and a careful

observation of these might prove to be of practical importance in the control of bollworm by means of parasites. The utility of trap crops and the advantages of sowing cotton as a mixed crop were also studied in connection with the control of bollworm.

In the Punjab, the American cottons remained free from bollworm attack throughout the season in 1915, but *deshi* cottons were attacked to some extent. Prompt measures were taken to supply all cotton-growing districts with large quantities of parasites which were bred at Hansi from the stock supplied from Pusa.

Rice pests. Various kinds of insects are known to attack this important crop and considerable attention was paid in most of the provinces to controlling the outbreaks of pests on paddy. In the Central Provinces *jassid* bugs locally known as *maho* have become a serious pest of paddy during the past two years and to help in the investigation and control of this outbreak a staff of Assistants was lent from Pusa. Collection by means of bag-nets was found to be most effective and large numbers of these were used with considerable success. The exact life-history of this insect is being worked out at Pusa. In Mysore putting kerosine in the water of the paddy fields was found an efficient remedy against *Nymphula depunctalis*, a caterpillar which feeds on paddy plants, while in Travancore another caterpillar which causes serious damage to young seedlings was dealt with in the same way and also by dragging a bamboo pole over the young crop. In Malabar and other parts of the Madras Presidency bagging demonstrations were made against various bugs and caterpillars attacking paddy.

Sugarcane pests. The work of rearing cane-borers and their parasites was continued at Pusa and evidence obtained to show that cane-borers are two or more species of *Diatræa* which may occasionally attack other cereal crops such as *jowar*, maize, millets, etc., and that the normal borer in these cereal crops is rarely found in cane. Further study is required before recommending means of control. As there seems some possibility of reducing the incidence of borers by varying the time of planting, experiments with this object in view have been started in the Central Provinces. In the Punjab, cutting out

of 'dead hearts' proved effective against all borers attacking young canes. A series of experiments was also carried out at Pusa on the protection of cane setts from the attack of termites with the result that lead arsenate proved to be the best insecticide for the purpose. The new shoots also require protection as they are most liable to be eaten into at the point of exit from the sett and experiments to this end are being undertaken.

Coffee pests. The Imperial Entomologist toured in Coorg in October and November to investigate the coffee borer which proved to be a serious pest of this crop there in 1915, and experiments were started to ascertain the length of life cycle of this insect as it has been uncertain whether there are one or two broods in the year.

Vigorous campaigns were organized in Mysore and other South Indian planting districts to control and check the outbreak of Green-scale-bug which is at present engaging the serious attention of coffee planters. Spraying operations were carried out and the planters are quite alive to the danger of allowing this pest to spread. The weather conditions, however, were unfavourable for its increase as they favoured the spread of the fungi that attack and destroy the bug. Demonstrations as regards the efficiency of utilizing these agencies were therefore organized in all estates in Mysore, and cultures of one of them were distributed.

Tea pests. The Entomologist of the Tea Association carried out experiments in connection with the control of the tea mosquito and the results though not yet definite seem to indicate that the liability of tea bushes to attack can be influenced by the addition of soluble plant foods to the soil. A study was made of termites and their depredations in tea as well as that of *thrips* insects which damage tea in the Darjeeling district and trials of different insecticides were carried out with success. The pests of green manures and shade trees in use in tea gardens were investigated and series of articles published in the Quarterly Journal of the Association.

Orchard and Garden pests. A special study has been made at Pusa of insect pests of cultivated fruits, vegetables

and flowers and a considerable amount of information has been collected as regards the life-history, occurrence and control of the insects concerned. Special attention has been paid to the collections of fruit flies and an important discovery in this connection was the occurrence of the European olive fly in wild olives of the North-West Frontier Province. This discovery is likely to be of importance in view of the attempts which are being made to introduce the cultivation of the European olives in North-Western India and Kashmir. In provinces increased attention was paid to the study and control of pests of various fruit trees. Experiments with spraying of mango and fruit orchards were so successful in Madras and North-West Frontier Province that orchardists are now themselves taking up spraying as a routine.

Insect pests of stored grain. A study of the pests of stored products has been taken up both at Pusa and in the provinces notably Madras, Bombay, the United Provinces, and Burma. The first year's experiments at Pusa show the lime treatment of rice to be satisfactory, the stored rice being rendered practically immune from all pests without impairing the edible qualities. Further trials on a large scale are now in hand.

In Madras and Burma fumigation experiments with carbon bisulphide were carried out with great success in the granaries of *raiyats*.

Miscellaneous. Besides the more important investigations detailed above field work was carried out on a large scale in most provinces against pests of various other crops, the attacks being dealt with either by mechanical or insecticidal means. Mention may here be made of the campaign on a large scale against *Agrotis ypsilon* on *Rabi* crops in Bihar and *Amsacta albistriga* on millets in Mysore, both of which are serious pests in particular localities. In the former case, the destruction of moths was attempted with 56 Andres Maire traps while, in the latter, demonstrations of the life-history and means of control were carried out in 42 villages and nearly as many schools and 40,000 moths were hand-picked in 6 of these villages where organized work was carried out under Departmental supervision.

Apart from field work, life-histories of numerous insect pests were worked out especially at Pusa and Coimbatore and a large amount of systematic work was done in the way of additions to the collections, identification, etc. The science of entomology is comparatively new to India, and there are many insect pests which are yet unknown or whose life-histories have yet to be worked out. Consequently this part of the work will engage a good deal of the Entomologists' time for some years to come.

Useful insects—Silk worms. Among the useful insects which serve the requirements of man the most important are those which are the source of silk, honey and lac. Of these three economic products, silk is the most valuable and forms the staple industry of some districts in India and other countries. The industry was an important one in Bengal, but it has declined owing to deterioration in the worms due to disease and other causes. The best means of reviving the industry appear to be in the direction of working up an organization for supplying disease-free eggs to the rearers and in the improvement of the silk worm by the introduction of exotic varieties, cross breeding and selection. Improvement on all these lines is being attempted and though it will take time for the industry to regain her old position yet some improvement is visible in its condition.

Among the silk-yielding species of insects, the mulberry silk worm is the most important. Of this species there are two groups: (1) univoltine, giving one crop in a year—these are the domesticated silk worms of China, Japan, Italy, France, etc., and (2) multivoltine which hatch four or five times a year and which constitute the chief mulberry silk worms of India. The univoltine races are considerably superior to multivoltine ones in regard to the quality and quantity of the silk they yield. If we can evolve a race combining the best characters of both indigenous and foreign races, it will considerably help the work of reviving the silk industry. Experiments in hybridization have therefore been taken up at Pusa and at the Sericultural Research Station, Berhampur, the idea being to obtain a cross which would retain the native multivoltine character, but yield more silk of the type and texture of univoltine races of Japan,

China, etc. Various cross-bred types have been obtained and some of the promising ones are now in the 26th generation at Berhampur. It must be remembered, however, that a type requires careful watching through many generations of rearing before it breeds true. It will therefore take years before the types now evolved are fixed. The results so far obtained, however, appear to show that the crosses thrive well and although the yield is less than the indigenous varieties yet the silk produced is richer in quality and, further, the resistance of the worms to disease is greater.

The Government of Bengal has also made a grant of Rs. 10,000 to Miss Cleghorn to continue her research relating to silk rearing. She has obtained a multivoltine hybrid race which is already in its 42nd generation. This hybrid behaved well in a trial last year giving 36 per cent. better produce than the indigenous race. It was reared during the year on a very large scale and a rigorous selection is beng made among the families with a view to making the race vigorous and immune to disease.

With regard to the introduction of univoltine races, experiments were made in sending the eggs to Shillong and Muktesar for cold storage and they gave satisfactory results on rearing in March. The eggs of this race require a certain degree of cold for the uniform and regular hatching, which is an important point in the rearing of silk worms.

Disease-free eggs were distributed to the rearers in Bengal through 8 central nurseries and the total sale proceeds amounted to Rs. 16,800 against Rs. 13,000 in 1913-14. The *raiyats* are said to appreciate the seed and higher prices are offered for it. There are two sericultural schools for training the sons of professional rearers from which 11 students passed the final examination during the year. One was given a subsidy of Rs. 250 for strarting a model rearing house.

The work on eri silk with a view to improve its production as a cottage industry, was continued at Pusa and eggs were supplied to 890 applicants, while instructions were given by correspondence to numerous enquirers with regard to rearing, reeling, dyeing, etc. Three students finished their course in sericulture, while three are still undergoing training.

There is no doubt that the sericultural industry as a whole has steadily declined owing to a variety of causes and if it is to be resuscitated work must be taken up on a systematic and organized basis. In order, therefore, to investigate the problem thoroughly, a special post of silk specialist was sanctioned for one year and Mr. H. M. Lefroy, formerly Imperial Entomologist in the Imperial Department of Agriculture for India, was appointed to it. He toured through the silk-producing areas of the various provinces, studied the conditions under which the industry is being carried on and has submitted a report which will receive attention in due course.

Bees. For some years past experiments have been conducted at Pusa with a view to ascertain what improvements can be made in the methods of bee culture. The results obtained have already been published in Pusa Bulletin No. 46. These refer to the Indian Bee. Experiments with European bees have been abandoned owing to the great danger of introduction of the Isle-of-Wight Disease into India.

In the Punjab, Mr. Cousins, whose services have been temporarily secured for assisting in the improvement of the existing methods of bee keeping in the hill districts did useful work in visiting various apiaries and giving advice and assistance in effecting improvements. Several of the Hill Chiefs are now taking interest in apiculture and through the efforts of Mr. Cousins it is hoped to establish the industry on modern lines in the hills. He has recently issued a bulletin on this subject which will prove of great use to those who propose to take up apiculture in the hills of Northern India.

(*f*) Pathological Entomology.

Mr. Howlett, Imperial Pathological Entomologist, was on leave during the greater part of the year. The work has consequently been mostly of a routine character, *viz.*, breeding and observation of various species of Tabanids which are pests of cattle and carriers of disease, mosquitos, ticks, etc., and affording help to enquirers. The main lines of enquiry in this section have been a thorough investigation of the factors which influence the more practically important activities of insects such

as pairing, egg laying, etc. Mr. Howlett had under observation flies and other insects which breed in decaying or septic animal matter, and he devoted special attention to chemical substances which exert an attractive influence on fruit flies. Success has already been achieved in isolating the actual compounds which are responsible for the "chemotactic" reactions of the males of three species of fruit flies. This discovery opens up a wide field for research, particularly in the direction of introducing more efficient methods of insect control.

During the absence of Mr. Howlett, the Imperial Entomologist has been in charge of this section. Life-histories of various cattle flies were studied and their feeding habits observed. An Assistant visited Kathgodam and Bareilly to ascertain the kinds of biting flies prevalent in the surra zone and to carry out transmission experiments. Two species of *Tabanus* and one of *Philoematomyia* were found capable of transmitting surra, the latter only in the case of an immediate interrupted feeding, the maximum interval between leaving an infected host and beginning to feed on a previously uninfected animal being only seven minutes. A full account of these experiments will be published.

The mosquito campaign which was organized in 1914 to control the breeding places on the Pusa Estate, was continued with considerable success, the reduction in numbers of mosquitos prevalent during the year being in marked contrast to the experience of previous years. Breeding places were sought out and dealt with either by filling in the hollows in trees, small puddles, etc., removal of tin-cans, pots, etc., holding rain water, oiling large semi-permanent pools or the introduction of larvivorous fish in more or less permanent pools, wells, etc. Pusa presents an opportunity to municipalities to learn at first hand how to deal with the mosquito plague effectually and at a small cost, and delegates deputed by them will be welcomed.

(*g*) Agricultural Bacteriology.

Work on agricultural bacteriology is comparatively of recent origin in India, and is practically confined to Pusa. In consequence some portion of the time of the Imperial Agri-

cultural Bacteriologist is spent in the elaboration of laboratory technique in connection with biological analyses of soils and in the training of students in the use of the methods elaborated in the laboratory. The main lines of enquiry continue to be an investigation of the soil conditions affecting the supply and utilization of combined nitrogen on the one hand and the production in, and elimination from, the soil of plant toxins or poisons on the other. A series of experimental field plots under wheat served to demonstrate the production of infertility in soil containing nitrogenous organic matter (oil-cake) as a consequence of semi-anærobic conditions artificially induced by water-logging. This infertility did not occur to the same extent when ammonium sulphate was substituted for cake, nor did the effect of water-logging become apparent until the roots of the plants reached a level in the soil where oxidation consequent on the cultivation had failed to reach. Similar experiments with barley demonstrated this effect more markedly owing to the later formation of the secondary root system in this crop and its consequent dependence for a longer period of its growth upon the original deeper roots. Laboratory work on nitrification and on the growth of seedlings in water and soil cultures illustrated the possibility of separating substances from certain bacterial cultures from decomposing organic matter and from anærobically incubated soil whose toxity to nitrifiers and in greater concentration to seedling plants was demonstrable under these conditions.

Among soil toxins produced by bacterial action nitrites are well known to exert a prejudicial influence upon plant growth and observations were made as to the cause of their presence and the degree of concentration required to produce prejudicial results. During the course of observations evidence was not wanting that in many of the soils examined the very slow rate of nitrification observed under optimum conditions of aeration and water content is due to the absence in sufficient numbers or lack of physiological activity of the necessary nitrifying organisms. The discovery, however, requires further substantiation by careful experiment and observation.

For some years past, Mr. Hutchinson has been carrying out in collaboration with the Imperial Agriculturist certain green-

manuring experiments with the object of devising, if possible, a better method of application of this manure. It was found by laboratory and field experiments that the main and controlling factor in the decomposition of the manure appeared to be the incidence of rainfall following its burial and, as this is frequently defective, a method of carrying out the initial stages of decomposition by rotting the crop in pits was devised and experimented upon. Very large yields were obtained and the method demonstrated certain advantages over the process in vogue. The results were therefore published in Pusa Bulletin No. 63, with a view to invite criticisms and suggestions as to the practicability of the method and the possibility of its application to various crops in various provinces. Experimental trials with it are being made throughout India and it is hoped that they will lead to more satisfactory results being obtained from the use of green manures.

Besides the main work connected with the fertility of soil, the Imperial Agricultural Bacteriologist carried out certain special enquiries on technical subjects. One of them was on saltpetre with a view to ascertaining the conditions which favour the occurrence of saltpetre in Indian soils. Conclusive results were obtained in connection with this enquiry and are being published in Pusa Bulletin No. 68. It was found that the output of saltpetre was limited at present not so much by the available supply of raw material as by the number of workers actually engaged in extraction, and an introduction of better relations between the *nuniah* and the refiner and a revision of the rules of the Salt Department would probably greatly conduce to the improvement of the industry. No special soil organisms appear to be associated with saltpetre deposits which are the result of the nitrification of organic matter accumulated in the neighbourhood of human dwellings. Experiments on a field scale showed the feasibility of increasing the output in soils, having sufficient lime content and suitable physical texture, by the use of nitre beds made up by burying a green crop, *e.g.*, sann hemp, in the soil and compacting the heaps sufficiently to ensure the capillary rise of water from the sub-soil to the surface, where the nitrate formed accumulates and can be scraped off after the manner of the *nuniah*,

An advantage of this artificial method is that the crude saltpetre resulting therefrom is comparatively free from sodium chloride. Thus a higher return of the pure product is obtained.

The *nuniah's* present methods of extracting the crude saltpetre are far from being economically sound, and can be greatly improved upon by some simple variation of his present technique. The possibility of improvement in the refining process has already been indicated in Pusa Bulletin No. 24 by Messrs. Leather and Mukerji.

Another important enquiry engaging the attention of the Imperial Agricultural Bacteriologist is in relation to fermentation organisms. Already results have been obtained which are most valuable to Indian distilleries. Improved methods of obtaining and utilizing yeast cultures of indigenous origin were experimented with and gave encouraging results. The use of mixed cultures of good types of *S. cerevisiæ* of Indian origin is reported to have given an increased yield of some 20 per cent. in the Nowgong Distillery in Central India. The method of re-inoculation devised in the Bacteriological Laboratory at Pusa was found to give considerably higher yields of alcohol in the same period of time. These results point to the necessity of having a special laboratory in India for the investigation of such questions.

At the request of Mr. Lefroy, Imperial Silk Specialist, Mr. Hutchinson undertook an investigation of the conditions of incidence of Pebrine disease of silk worms in India, the primary object being to determine whether the failure to avoid disease in India by using the Pasteur method of selection of disease-free 'seed' is due to any inherent inapplicability of the method to Indian conditions or merely to its improper use. The enquiry so far goes to show that both of these factors are responsible for the condition in Bihar and Bengal. From examination it was clear that in India the Pasteur method of examination as followed in Europe fails to eliminate all diseased eggs and in order to be certain of this being done, it will be necessary to alter the method and to make it more difficult and laborious. A further point of interest elucidated in the enquiry was that infection of larvæ, so far as Pebrine is concerned, does not take place at all after the third moult, with

difficulty after the second, but with comparative ease up to this stage in the life cycle. If this is confirmed by further observation, it will simplify the precautionary measures in rearing by relaxing them considerably during the later stages of growth. When optimum conditions as regards space, air and food were provided, in a majority of cases the progeny of even highly diseased moths did not develop the disease. It will thus be seen how great is the part played by sanitation and careful feeding in the elimination of the disease.

Another enquiry started during the course of the year was the one connected with the bacterial aspect of the fermentation taking place in the indigo steeping vats. It was taken up at the suggestion of the Indigo Research Chemist and is likely to prove of very great value in the manufacture of indigo. Great variations are known to occur in the yield of different factories from plants grown under similar conditions of soil and climate and important facts bearing on these variations were brought to light by this enquiry, the most obvious conclusion being that the differences are due to the presence or absence of specific bacteria which infect the steeping vats. The enquiry is at present in an initial stage, but is likely to prove of great benefit. Considerable improvements seem possible in the methods of manufacture by artificially ensuring the presence of the necessary organisms in the steeping vat. Numerous species of bacteria have been isolated and their physiological activities with regard to the process of fermentation studied. Some of them can be definitely placed either in the class of beneficial or deleterious organisms, but further work must be done before their true functions are fully understood.

Other work of importance having a bearing on bacteriology done outside Pusa was that of Dr. Harrison in connection with the gases of swamp paddy soils and of Mr. Barnes in connection with the reclamation of alkali soils.

(*h*) Agricultural Engineering.

Agricultural Engineering is destined to play an important part in the agricultural development of India. When we look

to the vast possibilities for the introduction of labour-saving appliances and for increasing the resources of irrigation from wells—the two most important problems which agricultural engineering attempts to solve—we get an idea of the good it is capable of doing in this country. When it is realized that an increasing amount of produce will be raised in the country as the result of increasing the sources of water supply available for irrigation the effects of which will be particularly beneficial in arid tracts, it becomes obvious that the work of Agricultural Engineers must increase in importance and value to India. Moreover it is becoming clear that the substitution of mechanical agencies for bullock power is one of the primary essentials of economic progress in a densely populated country like India where an extension of the food producing area means a proportionate reduction of that devoted to the production of fodder. The various problems of agricultural engineering require to be closely studied in each province by a qualified Agricultural Engineer. But it is only Madras, Bombay, the Punjab and the United Provinces that have so far got Agricultural Engineers on their staff, and it is in these provinces that considerable progress is being made in developing the existing sources of water supply and in the introduction of mechanical means of water-lifting. Were it not for the enhanced cost and difficulty in obtaining machinery and engineering supplies owing to the war the expansion of the work would have been still greater. A few years ago a hope was expressed that it would be possible to turn Upper Gujarat into one large garden by adding to the irrigation resources and this hope is being gradually realized. During the year under report the rains in North Gujarat were deficient and consequently a large number of boring operations were carried on there with the result that an addition of nearly 400,000 gallons per hour to the supply of water in the wells was effected. This, combined with the erection of power pumping plants on a number of the wells bored, produced a marked effect on the agriculture of North Gujarat. A comparison of figures of one district in this tract of the irrigated area in 1915-16, with those in 1911-12 which was also a year of short rainfall, shows that well-boring operations during the four years have effected an increase of about

4,600 acres in the area protected by well irrigation. Outside Gujarat the work of Dr. Mann on the subject of subsoil water in the trap area is very valuable. It indicates that the well water in this area is not a generalised subsoil water but water flowing in definite fissures and in a definite direction, and unless therefore its presence has been made fairly certain before-hand, digging a well does not always mean finding water. The Mansfield water-finder has been found useful in locating the streams of under-ground water which can be tapped. An interesting point brought out in the course of these investigations by Dr. Mann was the fact that in the case of wells near Surat, there is a likelihood of the well being rendered saltish due to infiltration of sea water when there is a long drought or when too great a proportion of the available water in a well is utilized. This indicates the necessity of putting a stop to any indiscriminate use of well water in this part.

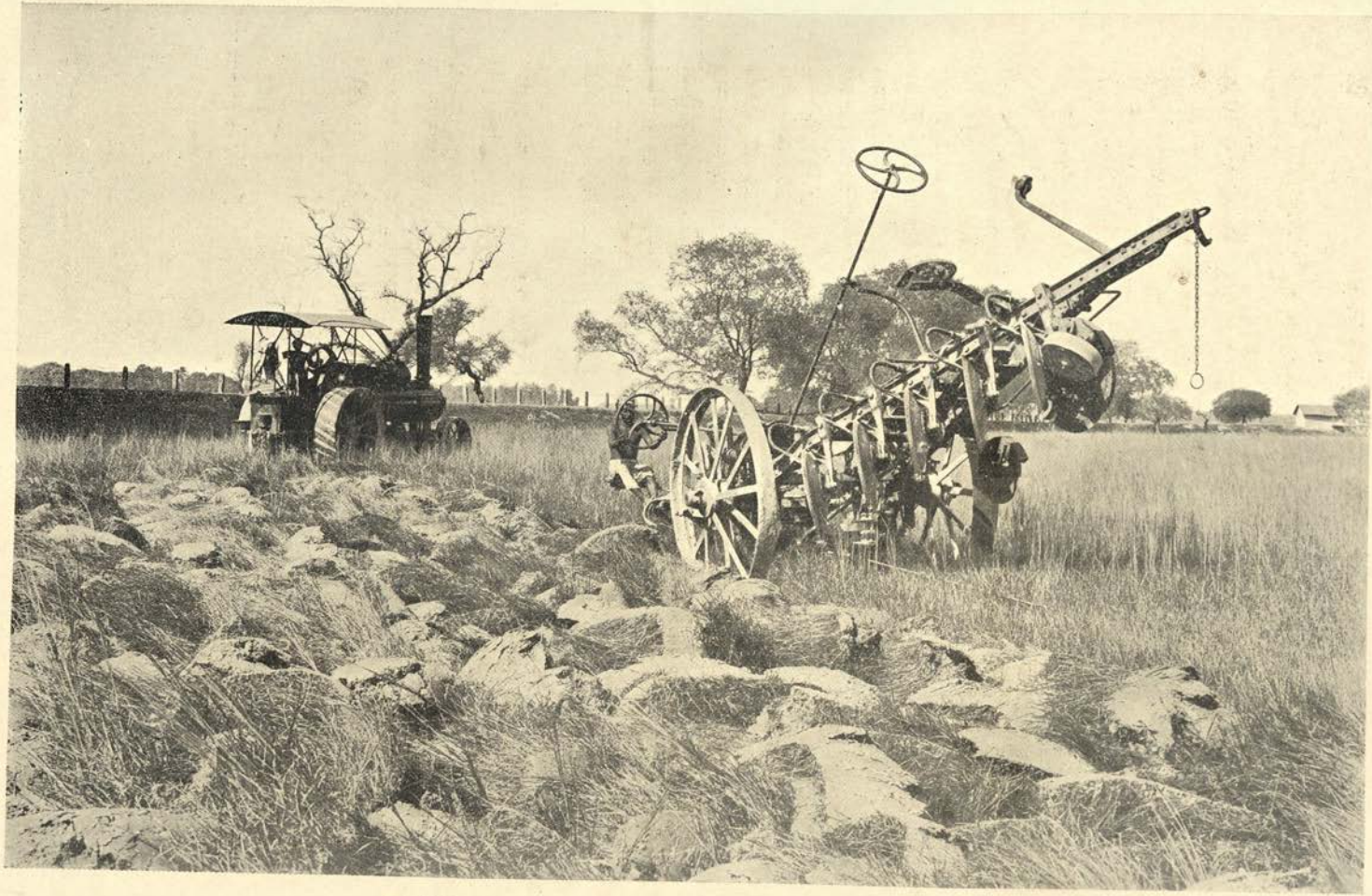
In the United Provinces, tube-wells have been found successful in most parts. During the last two years 30 large tube-wells have been put down in 20 districts. On the question of cost as well as the methods of sinking, etc., no final facts or figures can yet be given but the Department is now able to guarantee a successful well giving from 30,000 to 40,000 gallons per hour for continuous pumping. This class of well provides large quantities of water necessary to justify the use of mechanical power and various schemes for the installation of tube-wells of different sizes are in progress both in the United Provinces and in the Punjab. An average installation of this kind is capable of irrigating several hundred acres of land in a year and this indicates the great ultimate advantage of this class of work. In the United Provinces, some of the installations are to be run by co-operative societies, who will distribute the water to their members.

With regard to increasing the supply of water in the existing wells further progress was made in both the United Provinces and the Punjab in gaining experience as to the conditions and methods of working which would prove suitable for different parts of the provinces. In the former, it has been found that in those parts of the provinces where a clay foundation with underlying water-bearing sand is regularly met with

near the surface, success can invariably be attained by the existing methods of boring. An interesting experiment in such a geological formation was carried out in the Bulandshahr district where a copious discharge of water was obtained by pumping from a pipe sunk through the clay foundation without the construction of a well. Similar installations have been put up in two other places for the benefit of the adjoining villages.

In Bihar, a number of successful borings were made by the District Boards in the Patna Division and by the Well-Boring Department in the Tirhoot and Bhagalpur Divisions, but any great expansion in this work is at present limited by the number of trained staff available and by the enormous rise in the price of casing pipe due to the war.

Turning to the side of work relating to the use of mechanical power for other agricultural purposes we note a considerable advance made during the year notably in the United Provinces and the Bombay Presidency in the matter of cane crushing. It has already been realized that extension in the area under cane cultivation in India is at present governed among other things by the amount of bullock power at the disposal of the individual cultivator for cane crushing. It is not necessary to reiterate the advantages of mechanical power for this work. Suffice it to say that not only is higher extraction of cane juice obtained thereby much more economically, but it also sets free the bullocks for other agricultural purposes—a matter of very great importance in India where most of the agricultural operations of the *raiyat* depend on the efficiency of his bullock power. Any increase in the use of mechanical power in cane crushing is therefore a distinct advance in any district which cannot find the extra land to feed more bullocks. In Bombay, the United Provinces, and Mysore, various types of power crushers suitable for use on large estates or on a co-operative basis or for smaller areas have been tried and are being introduced in suitable places. Simultaneously with the introduction of improved methods of crushing, the methods of manufacturing *gur* are also being improved. The sugar crushing plant designed by Mr. Hulme, Sugar Engineer Expert, was worked during the year, but further trials with it are necessary before any definite opinion can be pronounced. It is designed on the smallest scale which,



DISC PLOUGH TURNING OVER WEEDY LAND.

in Mr. Hulme's opinion, can be worked on a commercial basis both for the manufacture of *gur* and sugar.

Steam ploughing. In many parts of India, there are large areas of virgin or grass-lands which are lying waste owing to the enormous cost and labour required in their reclamation by manual or bullock power. Further, there are large estates in some parts where the use of mechanical power for cultivation purposes might be more economical. In order therefore to study the facts and fallacies of steam ploughing at first hand some of the Departments have been making experiments with this class of cultivation either with their own steam tackles, as in the case of Bombay, the United Provinces, Assam and Pusa or by grant of land to a big Zamindar as in the Punjab. The results though not yet definite, are encouraging. In Gujarat 1,200 acres of rough land were broken to a depth of 1 foot and the clods harrowed at a cost of Rs. 16 per acre and it looks as if at this rate steam ploughing may be run as a business proposition in that part. In the Punjab, a grant of 2,000 acres of land was made a few years ago to a Zamindar for cultivating and growing improved seed of wheat and cotton for distribution. About 1,600 acres have been broken up and brought under cultivation and there seems ground to believe that it will pay to run a steam tackle for large and compact estates in the canal colonies.

The question of the economics of farm production is bound to become of increasing importance in future on account of the rising prices of labour and farm cattle. It is therefore highly necessary that the efficiency of labour-saving appliances in different parts of each province should be thoroughly tested and gone into, and the application of engineering skill to this part of the work is the best way to assist it.

CHAPTER III.

PROGRESS IN DEMONSTRATION AND CO-OPERATION.

(*a*) Demonstration.

Demonstration may be divided into two classes—

(1) by deed, and
(2) by word.

When one is dealing with the *raiyat*, the first speaks a great deal louder and explains a great deal clearer than the second and this is a point which may be taken to heart by all would-be demonstrators who desire their precepts to be remembered. For, after all, if you can get down and show a man how to do his job better than he can do it himself, he has plain evidence that you can teach him something. To merely *tell* him that you can—to wave degrees in his face—is to talk to him of things above his head. Such actions may mystify the humble majority but they merely incite the scoffer to scoffing, and make the worker wish to get back to his work, and in no way help forward the improvement of agriculture.

The object of demonstration is to show that by seed selection, more careful cultivation and by the use of better implements the productivity of the soil can be increased. These lessons are taught as much by seed distribution operations as by actual demonstration plots. The cultivator in India pays much more attention to the experience of his neighbour than to anything else, and it is by gaining the confidence of some enterprising individuals, whose example can influence the surrounding agricultural community, that a large measure of success in demonstration depends. This is therefore the principle on which the Provincial Departments are working, the actual methods being largely based on the local conditions. The results obtained on experimental stations are brought to the notice of the cultivators through agricultural associations, honorary correspondents, influential Zamindars or co-operative societies. The demonstrations are carried out at present by Agricultural

Assistants on demonstration plots either owned by Government or private bodies and are necessarily limited by the amount of the trained staff and expert supervision available. Consequently, the work is confined in most provinces to some definite areas, which can be controlled by the available staff. When circumstances permit of the full complement required in each province being enlisted, a considerable expansion in district work may be expected. Further, it is an accepted policy of the Agricultural Departments in all provinces that no demonstration should be undertaken until the merits of any improvement to any particular locality are proved beyond doubt by experimental work. Far-reaching results may be expected where the golden rule "no demonstration before experiment" is adhered to and we take the opportunity of again repeating this warning in order that the temptation to start off with the showy work of demonstration may not lead to the neglect of the rather less noticeable but absolutely essential work of thorough previous experiment—without which no form of demonstration can hope to be convincing. For the purpose of advocating agricultural progress and for getting at the heart of the rural areas, it is necessary to have a farm or farms in a suitable locality in each district managed by trained assistants to serve as a general depôt for seed supply and as a demonstration centre. It is obviously impossible for Government to establish so many farms and the best course is, where possible, to encourage private bodies to open them. This is being done in some provinces, where farms have been opened by big land-holders, District Boards, agricultural associations and co-operative bodies and the services of trained assistants have in some cases been secured for the purpose of carrying out the work of advocating improvements. In the Northern Circle of the Central Provinces, a scheme of running such farms by agricultural unions is reported to have worked satisfactorily. The Union controls a limited and compact number of villages and the farm which is some 30 acres in extent is acquired or leased. The Union has a capital of about Rs. 500, which is raised by means of shares, each member taking a minimum of one share which ensures a general interest in the management. A small area of this farm is devoted to the demonstration of improve-

ments advocated by the Department, while a large portion is utilized for the propagation of pure seed of a proved variety for supply to members.

The work of the Agricultural Department in India does not cease with the demonstration of any improvement; it immediately becomes necessary to arrange for the supply of the material also—either improved seed, implements or manures, and once the improvement has been generally taken up, this succeeding work requires time and energy. As it is practically impossible for the Department to grow the required quantity of the improved seed on Government farms, private agencies have been organized for the propagation and distribution of approved seed, and it is in the gradual development of relations with the private bodies that advance is now being made. The problem of cotton improvement is a far more intricate matter than that of any other crop as the question of quality is involved in it. It requires not only an efficient control over the seed supply so as to avoid chances of mixing by which the quality is deteriorated, but arrangements have also to be made for marketing the improved quality in the preliminary stages of development, and here the difficulties of finding a market for a small quantity at a good price constantly occur. The aim in the improvement of crops is to gradually replace the country crop by the improved kind over definite areas. The schemes differ in various provinces owing to natural diversity of conditions. They consist in either grouping together a number of villages and introducing the method of growing and handling the improved crop co-operatively, in organizing, in case of cotton, auction sales to enable cultivators to get an adequate price, in arranging to take back from selected growers seed at harvest time and then retailing it in the following season, or in giving special leases of land on condition that a certain area is devoted to the production of seed of approved varieties of crops. The best method is no doubt to organize co-operative growing and marketing of the produce and this is being attempted wherever possible. The time however is not yet ripe to expect any great development in this direction throughout India. The natural apathy of the cultivator has to be overcome, he has to be taught to appreciate his responsibility in the maintenance of the purity

of his seed; he must be made to take interest in the advantages of co-operation and finally arrangements must be made to organize the co-operative movement and to make it thoroughly operative. And last, but not least, he must be protected against a failure to find a market—as, the consequent discouragement would undo all the good done by the improved crop, for, after all, a bad crop which you can sell is always of more value than a good crop you can neither sell nor use yourself. Particularly is this the case with cotton where the grower is dependent on the requirement of the buyer for his livelihood. In the case of wheat which requires a comparatively large seed rate per acre, the important question of storage has to be solved. In some provinces, co-operative banks are storing wheat seed but any large development in this direction is obstructed at present by the difficulty of safe storage through the monsoon months and the risk of incurring a financial loss in case of any fall in price of grain between the harvest and sowing time.

With regard to implements and manures, these require investment of money which the individual cultivator is not in a position to spend. Some co-operative societies and banks store these for the use of their members, but considerable development is expected when cheap credit is available on a larger scale.

All along the line a rapid advance may be seen, in some places so rapid that the question of staff is becoming acute, and it will be a great pity if the march of these improvements is to be hindered not by there being no more lands to conquer but no more leaders to direct. In all other aspects the outlook is most promising, but here it must be realised that cessation of energies means stagnation and an immediate retrograde movement, which in India is all too apt to become permanent and to undo in a short time all the good which has been achieved.

With the above preliminary remarks, we may now review the progress in demonstration in the various provinces :—

Bombay. This Presidency continued to make steady progress in extending the utility both of her farms and of the district staff. The activities of the Department are developing in several useful directions, and a noteworthy point of achieve-

ment is that the staff is getting well into touch with the cultivators. The success of the vernacular schools, agricultural shows, formal demonstrations and special classes on some of the farms bear a clear testimony to the appreciation by the public of the Department's work. The Department has gained the confidence of the people to such an extent that most useful results are obtained by energetic members touring informally in the villages and advising individual cultivators on their own land. Four new Agricultural Associations came into existence and one became defunct leaving a total of 60. Some of them did useful work by engaging the services of trained men to carry out and advocate agricultural progress. Seven agricultural shows of some size and 150 formal demonstrations were held, and ploughing matches were arranged in connection with some of these shows. A striking advance was made in extending improvements in general farming such as the use of implements, manures, etc. The use of sulphate of ammonia and oil cakes and crude night-soil for valuable crops is extending and societies have been found for joint purchase of manures in lots. The implement campaign continues to be one of the most important lines of work, and a number of additional depôts have been started for their sale. The use of implements has become so popular that Rs. 2,800 were realized during the year from hire alone by some of the depôts and experiment farms.

In the matter of producing and introducing improved seed of crops, a good deal continues to be done especially with cotton and sugarcane. With regard to cotton, work is proceeding on the lines described in previous reports, *viz.*, introduction of Broach and Cambodia cottons into the southern parts and of American cotton into Sind, improvement of indigenous varieties in Gujarat by selection and the spread of *rosea* cotton in Khandesh. The Department continued to give help in the marketing of the produce by auction. In Surat District, the scheme referred to in last year's report, of forming a committee representative of the cultivators of a group of villages for growing and marketing improved cotton worked well and a second group of villages was added during the year. The prospects of American cotton in Sind are bright and, given favourable circumstances, much may be expected.

With regard to sugarcane, the general work in connection with the introduction of top dressings, improved *gul* making, economical furnaces and more efficient crushers continues to progress, but perhaps the most important work has been the demonstration of the possibilities of cane growing in areas opened by the new Godavari canals. The cultivation here is rapidly increasing and the Department is rendering all necessary help from the first principles of cane growing up to the last refining and handling of the produce. A cane growers' association was formed in the tract which is an important forward step.

Some parts of the Bombay Presidency are often affected with fodder famines, and the question of safeguarding the people in these parts against loss of valuable draught cattle is a serious economic problem which the Department has to solve. A scheme was evolved, a few years ago, to grow and store, at some suitable centres, fodder on a large scale for utilization in times of need, and this is being put into working order. Owing to severe fodder scarcity in the first year of its trial no storing could be done, but the preliminary work of erecting large fodder sheds and shredding and baling plant, clearing areas of grass land, and provision of grass cutting machines has been done, and as the prospects this year are better, operations of hay making and storing *kadbi* (Jowar stalk) fodder will be conducted on a large scale. We await with interest the result of these operations which, if successful, will be of the greatest assistance.

Madras. In Madras the work of demonstration continues to expand. The iron roller mills and the improved sugarcane furnaces are becoming more popular. The demand for iron mills has increased so much around Mangalore that three local factories have started to manufacture them.

The demonstration of the improved method of cotton cultivation on cultivators' fields continued during the year. *Raiyats* are supplied with pure seed on condition that the land is cultivated on the methods approved by the Department and the crop is sold to Government on the terms fixed. This system serves a double purpose : the improved methods are demonstrated to the *raiyats* and pure seed is obtained for distribution. The cultivators in the Tinnevelly District now appreciate the advantages

of the new selected " company cottons." In the year under report the Department sold 87,096 lb. of selected seed of company Nos. 2 and 3, sufficient to grow 8,700 acres. Besides these, the cultivators had already with them the seed of the last year's crop and the total area sown with these cottons is estimated at 27,000 acres. The demonstration of drill cultivation continues. The area under drilled cotton increased from 1,619 acres in 1910 to 17,060 in 1915-16. Attempts are being made to help the cultivators to obtain the full value for the quality of their crop by inducing them to sell their stock jointly to the ginning firms direct. The work is, however, hampered on account of want of unity among the cultivators. Still the practice is slowly gaining ground. In the year under report 89 cultivators belonging to 29 villages sold their crop direct to ginning firms as compared with 63 and 20 respectively in the previous year.

The efforts of the Department to popularize the use of superphosphate and green manure for paddy have met with a marked degree of success. The *raiyats* find the method of green manuring profitable. In certain cases the application of green manure was found to make a difference of Rs. 15 to Rs. 20 an acre in profit. The chief crops used for green manuring are *Dhaincha* (Sesbania aculeata), *Kolinji* (Tephrosia purpurea) and sunn-hemp. 170,515lb. of seed of these crops were sold as compared with 145,613lb. in 1914-15. To encourage the spread of this system Government has also granted concessions with regard to assessment and water charges on the land on which crops are grown for manure before the transplantation of paddy.

Plough demonstrations were held in many places which resulted in an increased interest in proved ploughs. There is still a great demand for the light " monsoon " plough.

The District Agricultural Associations continued to help the Department in distributing seeds, manures, implements, etc. and in popularizing the improved methods by demonstration and publication of leaflets. The Central Agricultural Committee was wound up as the development of the Agricultural Department has rendered its existence unnecessary.

Central Provinces. The most important and noticeable feature of the Central Provinces Department of Agriculture in the development of district work is the enlistment of an increasing

amount of sympathy and co-operation with the leading agriculturists throughout the province. This is evident from the rapid expansion of private seed farms, agricultural unions and branches of agricultural associations in various Taluqs of the districts. A considerable amount of energy is being devoted to the establishment of these organizations and supervision of their work with the result that phenomenal development is taking place in the spread of improvement in the cultivation of rice, wheat and cotton, the three most important crops of the province. Successful Divisional Conferences are held on the Government farms and are attended not only by a large number of cultivators and land-holders but also by Revenue Officials with whom the Department has organized very harmonious relations and who render great assistance in all that tends to the advancement of agriculture.

The tracts in which the three crops named above are most important are quite different, but the development throughout them has been a marked one and the measures recommended by the Department have been well received by the people. In the Northern Circle where the most important crop is wheat, there were 124 seed farms for growing selected seed and 12 agricultural unions for the spread of agricultural improvements. There were 3,500 acres under selected strains of wheat in certified farms in 1914 which provided seed for a hundred thousand acres in 1915, bringing an increased profit of 5 lakhs of rupees to the cultivators.

In the Southern Circle, the important crop is rice and here also the success in the spread of transplantation methods and reduction of seed rate and in the introduction of superior varieties of paddy was well marked. It is now 9 years since the Department started to demonstrate the methods of cultivating rice by transplantation in Chhattisgarh and within this period the area has risen gradually to 40,000 acres. The year 1915-16 was not a good year for the display of its advantages owing to a prolonged break in the rains and the area came down to 33,000 acres. The method, however, maintained its superiority over that of broad-casted rice, the average increase of grain being 712lb. per acre in 57 villages in which crop cutting experiments were carried out. This circle offers great possibilities of

development in this work as well as in the introduction of new crops owing to the facilities offered by Government by opening new tanks and canals, and the opportunity has been well utilized in demonstrating the value of irrigation and in introducing late-ripening and heavier-yielding varieties of wheat (including Pusa 12) and rice and valuable crops like sugarcane, groundnut and fruit. Another novel feature in this circle is the enlistment of the co-operation of big land-holders in the improvement of cattle. Two co-operative cattle-breeding farms have been opened and several other landowners are reported to be keen on the subject.

The Western Circle is made up of a cotton tract and here the work is chiefly confined to organizing the distribution of pure seed of *Rosea* cotton. The successful work of 'Cotton Unions' in this tract has been referred to in this report for some years past and it is not necessary to recapitulate it. Suffice it to say that these 'Unions' consist of groups of villages to form units and are engaged in the raising of pure seed of *Rosea* cotton for which there is a great demand throughout the tract. Besides these Unions, there are private seed farms which also produce and sell the seed of this cotton. During 1915, 673 tons of *Rosea* seed (sufficient for 150,000 acres) was distributed from the above agencies, and besides, large quantities of seed was produced by farmers themselves.

The demand for ploughs and other implements such as winnowers, cane mills, wire-fencing, etc., continued to increase, and a large number worth some Rs. 43,000 were sold from Government Depôts, Central Banks and private firms. Eighty tons of oil cake were supplied through the Department as manure to cane growers in the Southern Circle where cane growing has been demonstrated to be profitable, a net profit of Rs. 400 per acre being obtained in some places. Any considerable extension of cane cultivation here depends, however, on the availability of sufficient water.

United Provinces.—The provision of seed continues to be the main item of district work in these provinces, the special features being the employment of co-operative societies, Court of Wards Estates, and big Zamindars to take active part in the distribution of seed. Relations with co-operative societies

have been further developed especially in the Central Circle, and a few of the larger are making their own arrangements for growing and distribution of seed. Some of the Court of Wards Estates also are taking over the responsibility of raising and supplying seed to their tenants. In the Eastern Circle, the organization of private farms owned by well-to-do Zamindars is becoming a special feature of the work. There were 41 such farms in this circle most of which worked quite satisfactorily and realized large profits from the growth of seeds recommended by the Department. One farm having an area of 75 acres made a profit of Rs. 2,000 after paying for the cost of seed, labour and staff. These farms are not only useful in raising large quantities of approved seed but also render great help in assisting agricultural progress. In the Central Circle also, several Zamindars are now rendering valuable help by growing seed for the Department and by using their *sir** land as demonstration farms. The importance of seed distribution in these provinces can be gauged from the following passage from the Director's report:—

"The provision of seed continues to take up much of the time of the officers of the Department—in fact it is no exaggeration to say that it absorbs much of their time to the exclusion of other equally important duties. In the absence of any large seed farms, the bulk of the seed is grown by selected cultivators and bought back from them, being then retailed towards harvest time to small men cultivating only a few acres. This involves supervision over the growers' fields to see that no mixtures have crept in and a number of transactions, mostly on a petty scale. It also throws a heavy burden on the clerical staff, accentuated by an audit system not intended for this class of work. Some idea of the extent of these transactions can be drawn from the fact that in the Eastern Circle alone 16,343 maunds of seed were taken by growers, few of whom purchased more than a couple of maunds. In the above circle, there are 14 seed depôts managed by the Department and four by District Boards which are supplied with seed for sale. The demand for seed remains greatly in excess of supply, and, though organizations such as co-operative societies now render assistance, few of these can stand on their own feet and require constant supervision by the officers of the Department; while the majority still look to the Department for providing the seed. Owing to the small size of holdings in these provinces, seed farms are difficult to establish. Some of the larger landlords in Oudh have established

* The personal, family or private holding of a proprietor or landlord.

farms with the special object of supplying seed to their tenants, but this only meets the demand in local areas. The burden of meeting the demand is likely to remain for a considerable period on the shoulders of the Department, and can only adequately be met by large seed farms which will simplify operations by doing away with the necessity of arranging for growing through a number of small men. Further, it is obvious that unless there is some central seed supply of this nature, there is great difficulty in keeping new varieties pure."

Pusa wheat No. 12, Aligarh white-flowered and American cottons, J. 33 and Saretha sugarcane were the main crops, the demand for the seed of which was in considerable excess of the supply. About 200 tons of Pusa 12 wheat was distributed during the year by the Department. The suitability of this wheat to most part of the United Provinces has been proved beyond doubt and the question of replacing the country varieties is only a matter of efficient organization of seed supply. With regard to cotton, the Aligarh white-flowered is gaining popularity through demonstration farms in the Western Circle, 1,425 maunds of seed (for about 17,000 acres) being distributed by the Department during the year. The introduction of American cotton in canal irrigated tracts, however, received a set-back chiefly owing to an unfavourable season and shortage of canal water. The area sown was 1,200 acres, some of which was destroyed by the abnormal monsoon. As regards sugarcane, superior varieties are now available as a result of experimental work, but their successful cultivation depends to some extent upon wider application of manures. With a view therefore to bringing to the notice of cultivators a cheap material, the Department, by the help of a grant made by Government, distributed gratis to selected cultivators *Mahua* (Bassia latifolia) cake which is considerably cheaper than castor cake (at present the most common oil cake manure) and can consequently be more generally used with profit. The results of the trials are reported to be satisfactory.

There were 16 agricultural exhibitions in which different forms of agricultural machinery and implements were exhibited. The demand for implements especially ploughs was satisfactory although owing to higher prices, it was smaller than that in previous years. A grant has been made by the

Irrigation Department to extend the use of lever harrows in canal tracts, where the excessive consumption of canal water is attributed largely to the defective tillage of the soil.

Punjab. The most important work in the Punjab is in connection with the popularization of American cotton and improved types of wheats in the canal colonies. Selected types of both of these crops are now being grown on an increasingly large scale and the problem which the Department has to tackle is the growing and distribution of seeds of these to meet the demand, and also, in the case of cotton, to guard against the variety being mixed in the fields of the growers. The large grants of land which have been made in the Lower Bari Doab Colony for the purpose of growing the selected types of the two crops for seed purposes will be of material help to the Department in dealing with the question of seed supply. The area under 4 F. American has increased considerably. In 1915, there were 7,000 acres while in 1916 no less than 50,000 acres have been put under it, and greater expansion is only limited by the amount of seed available. The Department arranged for the sale of the produce by an auction at which about 7,000 maunds of cotton was sold at a premium of Rs. 2-8 to Rs. 4 over country cotton. There is a great future before this cotton in the canal colonies and it is expected that with organized efforts and favourable circumstances all the cotton area there will be under 4 F. American alone within a few years. It is interesting to note that one small village in the Jhelum Colony has been induced to grow in its entire area only 4 F. American cotton and Punjab 11 wheat—an example which, if followed, would considerably facilitate the marketing of the produce and avoid risk of any admixture.

With regard to wheat about 27,000 acres were grown by cultivators with Punjab 11 and 2,000 acres with Pusa 12. Punjab 11 is reported to be specially suited to the colonies, while Pusa 12 is becoming popular on well irrigated land in the central Punjab. About 47,000 maunds of seed of these two types were stored for sowing in 1916 by the Department, the Central Banks, and selected growers.

Agricultural Associations helped by District Agricultural Assistants continued to be the principal means of spreading

improvements. In addition, demonstrations were given at fairs, and touring parties were sent to many villages to show the use of improved ploughs. Besides, some District Boards have started demonstration farms and have employed Agricultural Assistants to supervise them. The demand for reapers was small compared with previous years owing to the availability of cheaper labour at harvest time, but the sale of Meston ploughs increased from 664 in 1914-15 to 906 in 1915-16 although the prices have gone up owing to the war. Some banks are stocking these ploughs and arrangements are being made with the supplying firms to make these banks their sub-agents, the banks getting a small commission on sales.

Bihar and Orissa. Agricultural Associations continued to be the chief agency for disseminating information, although co-operative credit societies were utilized to a greater extent than in the previous years for the introduction of improved methods of agriculture, seeds and implements. They were most useful in the introduction of Pusa wheat in the Patna Division. With the appointment of Deputy Directors in each Division, the Divisional Agricultural Associations have been abolished and the duties of co-ordinating the work of District Associations entrusted to the Deputy Director. The work of the District Associations will be guided by the District Inspectors of whom 9 were working in different districts during the year under report. The demonstration work was confined to these districts only, but except in one Division (Orissa), the Associations are reported to have failed to perform their functions satisfactorily probably owing to lack of interest among the members. The Associations in the Orissa Division are reported to have done much useful work in the introduction of certain superior varieties of paddy and wheat, green manuring of paddy and of improved methods of *gur* making. Some of the Associations have small farms which facilitate the work of demonstration.

Eleven agricultural shows were held, in some of which practical demonstrations were given in the improved process of *gur* making and in pumping water for irrigation purposes.

Bengal. Owing principally to the administrative redistribution of recent years, Bengal has suffered severely in respect of systematic agricultural development. The presidency is natur-

ally divided into East and West Bengal which are agriculturally quite different tracts, and before the last redistribution the work of the research station at Dacca was confined to the crops and conditions of East Bengal with the result that even after the redistribution the expert staff were fully occupied with the study of conditions and crops relating to that tract. In Western Bengal therefore, no material advance could be made except in the popularization of certain manures, the value of which had been proved on experiment stations, and the Director reports that " under the most favourable circumstances it will unfortunately take many years to bring the crop selection work in Western Bengal up to the high standard obtained by the expert staff at Dacca. As a consequence the district demonstration work in West Bengal cannot hope to meet with the same success as in East and North Bengal." In the matter however of application of bone-meal, green manure and castor cake on paddy and of castor cake and nitrate of soda on jute, a substantial advance has been made in proving beyond doubt the possibility of the economical use of these manures, and their application on a large scale is a matter of efficient organization to enable cultivators to purchase them. The use of these manures was demonstrated on a number of cultivators' plots during the year and the good effects of bone-meal and *Dhaincha* green manuring on paddy were very apparent. The increase in yield of paddy due to bone-meal was in one case as high as 13½ maunds per acre. Groundnut and superior varieties of potatoes were also tried on *raiyats'* plots in some districts with success. From the two seed stores, one in each Division of West Bengal, 90 maunds groundnut seed, 42 maunds *Dhaincha* seed for green manuring, 614 maunds bone-meal, 393 maunds castor cake and 74 maunds nitrate of soda were distributed.

In Eastern Bengal, the result of Mr. Hector's work on paddy and that of Mr. Finlow on Jute is bearing fruit and considerable developments are expected in the raising and distribution of the selected types of these two crops. Comparative tests were made on *raiyats'* fields with Mr. Hector's selected paddy seed and the average outturn per acre in one district was 600 lb. better than cultivators' varieties and in another the difference was 320 lb. per acre. A great demand has sprung up for this

seed. About 700 maunds were distributed during the year on condition that the Department can buy the whole crop for seed if necessary, so that a large quantity will be available for next season. Similar success has also been attained with Mr. Finlow's selected jute seed (Kakya Bombai No. 7). Trials were made on 40 different plots and the crop indicated superiority over local kinds; 25 maunds of seed were distributed to the cultivators in one Division. Besides improved seeds, the enormous economic possibilities of bone-meal and lime throughout the red laterite tract in the Dacca and Mymensingh districts were strikingly demonstrated. Their application is now regularly practised by cultivators round the Dacca Farm. Over 550 maunds of bone-meal were supplied to the cultivators of the Dacca Division.

The demonstration work in Bengal is done mostly on cultivators' fields by a number of demonstrators in charge of District Agricultural Officers and supervised by the Superintendent of Agriculture of the Division. Some members of Agricultural Associations however also carry out in their fields certain demonstrations recommended by the Department and assist in the distribution of seed and implements. There are at present 2 divisional, 13 district and 5 branch associations in Bengal in addition to the Provincial Agricultural Association. Agricultural shows were held in seven places. For the sake of storage and seed supply, stores have been opened in each Division from which a total of 489 tons of seed, 145 tons of manure, 133 implements and 1,86,000 sugarcane cuttings were issued during the year. The Department buys back the seed from selected growers and issues it again in the next season. These stores, however, especially in East Bengal, will be found insufficient to store the required quantity of selected jute and paddy seed the cultivation of which is bound to grow up rapidly and some arrangements will have to be organized for the raising and distribution of the seeds. In this connection it is satisfactory to note that a co-operative society has been started in the Darjeeling district to grow seed potatoes of Darjeeling and Naini Tal varieties for supply to the cultivators in the plains.

Assam. The work of this province is as yet in the preliminary stage of development and consequently big results cannot

be expected. Up till recently there was only one Deputy Director and although a second has been appointed, the absence of the first on military duty means no gain at present. The work of improvement of paddy, the chief crop of the province, is yet in an experimental stage, while much remains to be done in the matter of training an adequate staff. Much progress has however been made in certain definite localities in the matter of popularising results obtained on the experimental stations. The subjects to which the Department has paid special attention are sugarcane, potatoes, and manures for rice. Demonstrations with superior varieties of cane were made at 22 centres in two districts and in all cases a considerable increase in the weight of *gur* per acre resulted from their use. There was a large demand for sets, but only 92,000 could be supplied. Similar results have also been obtained in the introduction of superior varieties of potatoes in the hills. The use of bone-meal on paddy is increasing and the Department has set up a grinding mill at the Upper Shillong Farm for grinding bones collected locally. 283 maunds of bone-meal were manufactured during the year out of which 241 maunds were sold. Efforts to extend terrace cultivation in the Lushai and Abor Hills are giving satisfactory results and are of greatest importance in that they point to the possibility of substituting this sort of cultivation in place of the present practice which causes much denudation.

As in previous years, honorary correspondents gave valuable assistance in demonstrating improvements. There were 27 such correspondents in 8 out of 14 districts of the province and some of them obtained unusually successful results in the trials of sugarcane, paddy and manures.

Burma. The demonstration work in Burma is gradually expanding simultaneously with the expansion of experimental work on agricultural stations. The main crop of this province is rice, but there are great possibilities for other commercial crops such as cotton, wheat, sugarcane, groundnut, pulses, maize and sesamum. The work on some of the agricultural stations is not yet far advanced, as they have only recently been opened but on the older established agricultural stations substantial results have been obtained, for the dissemination of which district organization is being slowly built up. The work is neces-

sarily confined at present to such areas as can be controlled and supervised by the subordinate and superior staff available. The main items of work are the popularization and distribution of the improved seed produced on the experiment stations and the demonstration of improved implements suited to local conditions. The principal idea in seed distribution is to have a combined seed and demonstration farm in each district from which seed of proved value will be supplied either to co-operative credit societies or to selected cultivators who will agree to take seed yearly from the seed farm, multiply it and sell it to their members or neighbours. A large quantity of seed of improved strains of paddy worth Rs. 8,000 was in this way supplied from the Mandalay and Hmawbi Experiment Stations, and with the establishment of seed farms in each district a considerable development in seed distribution is expected. Five such farms were established by the end of the year. These farms will be in charge of District Agriculturists and will serve as his general depôt and demonstration centre.

A certain amount of progress has also been reported in the encouragement of the use of improved implements, and about Rs. 6,000 worth of them were sold from the agricultural stations.

Co-operative societies are likely to play an important part in the development of district work in Burma. There are already many such societies, and the year was marked by the formation of others in several districts. When the requisite increase to the superior and subordinate staff is found possible and the agricultural stations are in full working order, these societies will be of great help to the Department in the direction of co-operative organization and propaganda.

Native States. Among the Native States, Mysore continues to make steady progress in the development of the agricultural resources of the State. It maintains an adequate staff both for experimental and district work and although progress is handicapped in some localities owing to the lack of a subordinate trained staff and also of experimental results, a distinct advance has been made in gaining the confidence of the agriculturists. The holding of a number of district and Taluk conferences where

SPRING-TOOTH HARROWS FOLLOWING STEAM TACKLE.

lectures and demonstrations of improved methods were given, was a special feature of the work during the year. Besides, a very large number of enterprising cultivators were persuaded to carry out the recommendations of the Department. Ploughing demonstrations were in this way carried out at 600 different places with the result that about 900 ploughs, 1,000 plough shares and other accessories were sold from implement depôts. The advantage of threshing *ragi* (Eleusine coracana), *jola* (Sorghum vulgare), two of the important food crops of the State, by means of stone rollers and that of a threshing machine for *ragi* were successfully demonstrated. As the prospects of cane growing in some parts of the State are bright, the Department is distributing superior varieties of canes and demonstrating improved methods of jaggery boiling. The use of oil cakes for cane is also being popularized with success, nearly 1,186 tons being distributed during the year. The advantage of green manuring for paddy and of economic transplantation is being appreciated by the *raiyats*. As a result of experimental work, some high yielding strains of *ragi* and some special varieties of groundnut and paddy are now available and an attempt is being made to appoint certain selected growers for the propagation and distribution of the selected seed.

In the Travancore State, the main progress has, as in the previous year, been in the popularization of manures for rice and coconut and of methods of single seedling transplantation of rice. The value of manures, which consisted chiefly of local stuffs (oil cake, prawn skin, ash, etc.) sold by the Department during the year amounted to Rs. 11,000 as against Rs. 7,000 in the previous year. Besides, some *raiyats* purchased from other sources manures worth about Rs. 26,000. Demonstrations in the economic transplantation of rice were given in 26 different places and the method has been adopted over 10,000 acres. It has been found to bring about a gain of Rs. 15 per acre. With the co-operation of a few cultivators a large quantity of seed of Banku paddy recently introduced into the State was distributed.

The Baroda Department of Agriculture has comparatively a small staff and although some progress is reported to have been made especially in demonstrating the advantages of irrigation and in distributing some selected varieties of cotton and

groundnut, yet " the difficulty of finding matters of proved value for introduction " is considered to be one of the causes of the lack of interest on the part of agricultural associations which numbered 21 during the year under report. There is a possibility of oil engines and pumps coming into use for irrigation purposes as the result of advances of money which are given for the purpose by the Durbar to keen cultivators. Perhaps the most important piece of demonstration work in this State is the provision of a farm for the training of the aborigines in improved farming. About 99 boys and girls of the hill tribes work on this farm and are receiving practical lessons in husbandry.

(*b*) Co-operation.

Side by side with agricultural development the great economic stimulus of co-operation continues to progress. *The co-operative movement in relation to agriculture* was discussed at the last meeting of the Board of Agriculture in February 1916 and ten important resolutions were passed on the subject. The most important of these was in reference to agricultural associations which were declared to perform useful functions where a central co-operative association either does not exist or is not fully developed. The Board considered that even where these do exist there is no need to discourage agricultural associations where members really do pioneer work—but where central co-operative societies are fully developed the agricultural department should use them first and foremost as a means for demonstration and the introduction of improvements. Central banks as such should not employ their working capital in commercial enterprises; for the distribution of seed, implements and other similar activities they should either act as agents or else raise separate capital or make allotments out of profits or reserve.

In the opinion of the Board cattle insurance is unsafe unless adequate arrangements are made for dealing with outbreaks of epidemic diseases and the fixation of tariffs depends on local conditions based on more satisfactory actuarial data than at present exist.

Turning to agricultural co-operation other than credit, we find in Bombay societies for the sale of manures and co-operative

dairies. The biggest manure supply society is at Baramati on the Nira canal where the introduction of canal irrigation has opened out possibilities for the cultivation of sugarcane on a large scale. The society does business to the extent of a lakh of rupees in importing oil cake and distributing it on credit among the cane growers. The manure supply society at Kelva-Mahim referred to in last year's report continues to prosper and has supplied *ghani*-pressed cake from Northern Gujarat worth Rs. 18,000 to its members. Similar societies have also been started in other places and a systematic effort is being made to develop new canal areas by the provision of facilities for credit. This system is also adopted in Burma in connection with areas opened up by new canals and areas thrown open to cultivation by disafforestation, etc. Co-operative dairies continue to prosper in Bombay. The ground has been well prepared for further developments when the money difficulty which handicaps the movement at present in the Presidency is solved. Among sale societies, the auction sales of jaggery produce on the Nira Canal merit attention. The supply of machinery and implements by co-operative societies is also gradually expanding. In the Central Provinces, we note that Mr. Crosthwaite, Registrar of Co-operative Societies, has suggested the "Haas" system of co-operative organisation which is a more suitable system for dealing with advanced problems of co-operation such as sale and purchase of implements. He writes:—

"The successful practice of co-operation in agriculture postulates on the part of the cultivating classes, an ingrained appreciation which only years of patient work can instil. Universal experience, in fact, teaches us that rapid progress is not to be expected in these the most difficult branches of rural co-operation. There is, moreover, a serious difficulty in financing societies of this advanced kind. Their enterprises are generally on a large scale, their liability is limited, the sums they require are large, and the credit they want is long-termed. Such societies are not suitable customers for a Central Bank of the Raiffeisen type and for them we find provided a separate system of organisation following what is generally known as the "Haas" system. Under this system membership of the primary society is not confined to the narrow limits of a single village or parish, but may extend to a larger, though definitely restricted, area. This area must not be so large as to prevent the holding of meetings which all members can easily attend. The main objects of a Co-

operative society of this kind are supply, purchase, sale or production—perhaps a combination of two or more of these objects; credit is not the main object although some credit may be necessary in order to secure the main object. Founded on a basis of limited liability, share capital is, of course, an essential feature of these societies, and furnishes the necessary pledge, earnest money, or margin of security required by lending institutions. Sometimes the share capital is wholly paid up; sometimes a definite liability is incurred in addition to the share or shares taken and, in a comparatively few instances, shares are subscribed for but are held in reserve liability. The societies are generally arranged in groups and are affiliated to a central union in which the units of the group are enrolled in membership. The Central Union is a society with share capital and limited liability, the shares being held by the primary or unit societies which are its members. Generally speaking, the societies and the central union alike are not banking institutions at all; in some cases, it is true, they accept deposits from their own members, but their ordinary channel for credit, when such is necessary, is the apex or provincial bank. This apex bank deals with the Central Unions, and the Central Unions in turn dispense credit to the primary societies. Credit is not allowed for general purposes, but only for such specific objects as are clearly laid down in the bye-laws of the primary societies. For audit, supervision and control the primary societies and the central unions come under the wing of the provincial federation. Thus although the central co-operative banks of the Raiffeisen type conduct their entire business on a basis of unlimited liability, the provincial banks and federations have working under them distinct organizations which follow what are generally referred to as the systems of Raiffeisen and of Haas."

In the Western circle of the Central Provinces and Berar there are now 40 cotton unions of the kind described in previous reports. Of these 12 only are registered while 28 remain on probation under the Department. The 12 registered Unions produced and sold 591,131 lb. of pure *roseum* seed and made a profit of Rs. 56,303.

The unregistered Unions have sold 621,555 lb. of pure *roseum* seed during the year and made a profit of Rs. 51,553.

In the Southern Circle there are two societies for cattle breeding in Raipur District and two *Gaolis* Societies in Nagpur. These two Societies of *gaolis* made a profit of Rs. 4,778 and their herds have increased during the year to an appreciable extent. These satisfactory results are due to the fact that the Department has filled the place of the wholesale dealers and so done

away with a middleman's profit. For the success of such enterprises a cheap supply of feeding stuffs is essential.

Of the two cattle breeding societies the one at Nawagaon started three years ago has sent out the first batch of young bulls, 8 of which have been taken over by their owners for stud purposes in their own villages. A rice seed union at Kusmi in the Drug district is an important innovation. Its aim is to spread two rices which have been proved to yield largely on the Raipur Farm. In its first year this union produced 84,000 lb. of pure *gurmatia* seed. We look for important developments in this line in this tract.

In the Northern Circle, the type of registered seed union evolved by Mr. Evans is proving a great success. The wheat unions stored about 1,30,000 lb. of pure seed and the rice unions about 18,100 lb., which points to a large area being sown. We quote Mr. Crosthwaite on the difficulties surrounding the organization of such societies:—

"I have referred to the universal difficulties which beset the organization of agricultural co-operative societies for supply, production and sale; and in particular, I desire to emphasise the danger of asking co-operators to attempt things which are beyond their strength. In 1889 Grass and Mendel preached to German agriculturists already impregnated with the co-operative idea, the advantages of societies for the co-operative sale of corn. In 1896 the Prussian Government lent five million marks for the construction of co-operative corn-elevators and corn caves. In 1904 the same Government appointed a Commission to enquire into an almost unbroken series of failures; and the Commission reported that the German farmers had found this very advanced form of co-operative enterprise beyond their powers of management. In Ireland it took Sir Horace Plunkett two years to form one agricultural society, and four years to form about 50 societies; and it is probable that there would, even to-day, be no co-operation in Ireland but for the Irish Agricultural Organization Society, which, at the outset, a self-constituted body of propagandists, has slowly transformed itself into the executive of a democratic parliament of affiliated societies."

In Bengal, the co-operative movement is now playing a recognised part in the development of agriculture. Through the village banks in the neighbourhood of the Dacca Farm the members purchased about 500 maunds of bone-meal. In the Raipur Thana, the local co-operative societies helped in supply-

ing 2,000 maunds of suitable potato seed to their members. A scheme has been taken in hand for the propagation of Mr. Hector's selected paddy—Dacca No. 1—through the co-operative societies. The Registrar notes that the expert officers of the Dacca Farm have been very successful in making use of the co-operative societies for the introduction of improved agriculture. He adds that there is now a better understanding between the officers of the two Departments and he thinks it will be possible in next year's report to report further developments. The formation of the Khelar Irrigation Society is of great interest. Its object is to secure an even distribution of water for irrigation by the construction of a *bundh* across a stream. The Dacca Co-operative Dairy made a profit of over Rs. 2,000 during the year. The success of this dairy may lead to the formation of others and so help to solve the problem of milk supply to large cities. A cattle insurance society has also been started in this province but it is not yet possible to judge of its prospects.

In the United Provinces, there are now five cattle insurance societies working. In these provinces, organisation of agricultural improvements has continued and almost all central societies are now agents for the supply of improved seed to their members. In particular, Pusa 12 wheat is being introduced on an increasing scale. Dr. Parr's Aligarh White-flowered and American longstapled cottons are also being popularised by this means in the western and central districts.

The initial preparations for irrigation societies have been put in hand and it is hoped by this means to solve many of the present water difficulties. Many banks now stock implements of a simple and inexpensive type and this all goes to help the Agricultural Department.

Special reference may be made to the Conference held at Lucknow in February 1916, when various papers of great importance and interest were read by the Hon'ble Mr. Hailey, Mr. Burt, Mr. Oliver and others. These agricultural papers dealt with co-operative sale of manures, the management of the milch cow and tube-wells. Some of the papers have been published in the Agricultural Journal of India for April 1916.

The progress of the co-operative movement in the last 12 years has been most encouraging, and co-operation now forms the most important factor and agency in agricultural development. In addition, habits of thrift and of business methods are being developed and a spirit of self-reliance engendered which makes for progress.

Unfortunately this review is somewhat incomplete as the reports from certain provinces have not been received in time to permit of reference to the year's working. But what has been recorded above gives some indication of the expanding agencies of the movement.

CHAPTER IV.

Agricultural Education.

The subject of agricultural education is coming into prominence with the development of the work of the Agricultural Departments. The main objective is to improve the agricultural methods at present in vogue in the country, and to achieve this, it is necessary not only to provide a higher scientific training which will ultimately fit Indians to help in agricultural investigations, but also to provide for such practical education as will enable the majority of them to apply to the land the lessons of improved agriculture—in short to act as demonstrators of the best agricultural practices. At present, there is a great demand for the latter class of men especially to fill posts in the Agricultural Departments, and the energies of the agricultural colleges will, for sometime to come, have an ample scope in the thorough training of this staff. There is however no reason why it should not be possible to provide at the same time for an education which will also be of practical use and assistance to the sons of land owners and men of that type, and it is for the solution of this question that the scheme of education in the colleges has recently been revised. The standard curriculum previously adopted in these colleges consisted mainly of a number of independent courses which had no reference either to general education or to their suitability to the practical agriculturist, and it was hardly to be wondered at that the result failed to attract students. This led to the total revision of the policy by the Board of Agriculture in 1913. No such uniformity is now being observed and each province has framed its own scheme with reference to the stage of general educational and agricultural development current in that province. Broadly, the change consists in providing two courses, *viz.*, one practical and the other of a more advanced nature. The former is primarily intended for the sons of landowners, who want to return to their own land, but will also be of such a nature as to enable those taking it to fill appointments as agricultural assistants. The latter will be suitable for

those who are candidates for posts in the higher subordinate service. The two courses are not separate except in the United Provinces where the practical course is given in vernacular, while the other (diploma) course is in English. In other provinces, the first (practical) course will qualify the best students to take up the higher course devoted to the sciences in their application to agriculture. The syllabus of studies has been framed according to local conditions. The change is only recent, but appears to have brought about promising results in increasing the popularity of the colleges as will be seen from the following account of the work of 1915-16.

At the Coimbatore College, more than 203 applications were received for admission but only 43 students were admitted after preliminary examination. As this number includes only 9 students from the Telegu Districts efforts are being made to draw more students from these parts. In the first course, simple manual training in blacksmith's and carpenter's work was introduced for the first time during the year, and there can be little doubt that this makes a distinct step forward in the training of future agriculturists.

The change that has come over the Agricultural College, Cawnpore, after the starting of the new courses is remarkable. The number of students on the roll was 111. That the vernacular course has proved attractive is an undoubted fact, if one judges by the number of applications received. About 80 per cent. of the students in the vernacular courses are zamindars, sons of zamindars, students from Native States or boys detailed by large zamindars. A large number of these students are expected to return to manage their own estates or to work on the land. There appears to be a genuine demand for agricultural education on the part of the well-to-do classes and now that the status of the college has been improved by the exclusion of the Kanungo class, it looks as if it might in time be a high class college for the training of well-to-do boys who will subsequently have personal connection with the land. The outlook of the college is thus very hopeful.

In the Lyallpur College, where the new course consists of four years divided into two parts, 40 students were admitted in the first year class and there were 19 in the 2nd year in July,

1915; 16 of these, however, resigned and two more were dismissed; the total number therefore at the end of the session was 41. A keener interest has been shown by the public in the college work, and an increasing demand for admission is reported this year. Many District Boards are giving scholarships to students and a demand having sprung up among private land-owners for diplomates of the college as managers of their estates, there is a great likelihood of the college increasing in importance.

In the Nagpur College, the revised course came into operation this year. The main difference between the old and the new courses is that, in the former, for the first two years, attention was mainly devoted to purely scientific training while applied subjects, chiefly agriculture, were left till the third year. Under the latter, which is complete in itself, practical and theoretical agriculture, including as much allied science as is necessary, is taught during the two years. This course is also taken as a preliminary to a higher course of from 1½ to 2 years which will lead up to the degree of L. Ag. Candidates for the degree course will be selected from students who have successfully passed through the two years' course. The effect of this change in the curriculum has been very marked and 41 new students were admitted.

In the Sabour College (Bihar) also, the change in curriculum came into operation this year. At present a two years' (practical) course has been adopted as a trial, and a further course for students qualified and desirous of obtaining a diploma will be considered later. The new course is at present running alongside the old three years' course which will automatically terminate in 1918. The total number of students on the roll was 36 as compared with 20 in the previous year. The increase is attributed to the fact that the two years' new course appears to be more generally acceptable than the old one.

Burma has not yet opened an agricultural college but in view of the rapid expansion of the Department, it seems probable that steps will soon have to be taken to provide the necessary training locally.

Among Native States, Mysore has an agricultural school (with a two years' course), which is reported to have worked well. There was a total of 18 students on the roll in 1915-16. The most noticeable feature of this school however was the enlistment of co-operation of the District and Taluk bodies in the matter of spreading agricultural education in the State, with the result that they granted scholarship to students and 41 joined the school in 1916. This is the largest number in the history of the school and every district in the States is represented by the students.

With regard to higher training, the Poona Agricultural College which is affiliated to the Bombay University aims at giving comparatively higher agricultural education, while post-graduate courses in special subjects are given at Pusa. The curriculum of the Poona Agricultural College has been thoroughly overhauled on the recommendations of the committee appointed by the University Syndicate in 1915. The revised course came into operation during the year under report and is likely to be popular, as 54 new students, the largest number the College has ever had, joined the first year. Nine students were receiving training in post-graduate courses at Pusa, *viz.*, 3 in Bacteriology, 3 in Entomology, 2 in Mycology and one in Agriculture. The demand for higher education is bound to increase with the development of work of the Agricultural Departments. When investigation and research have provided the material, the necessity will no doubt arise of more advanced instruction bearing on Indian conditions and arrangements will have to be made for the thorough equipment of the colleges so as to be able to give the requisite class of training. A proposal to affiliate the Lyallpur College to the Punjab University is now under consideration.

A large majority of the agricultural population in India is either totally illiterate or has only a rudimentary education and to such the only method of imparting agricultural education is the demonstration of improved methods. This is done by the Departments either on the cultivators' own fields or on Government farms. In some provinces regular classes in particular subjects are held on the farms, while in others, parties are invited and shown the improved methods. Besides

this illiterate section, there is the son of the small land-owner who is better educated and will either farm or manage his own estate. This class will benefit most by short courses adapted to their general education. The experiment made in the Bombay Presidency in the establishment of vernacular schools is on these lines and the success already gained is one of the greatest achievements of the Department. There are at present three vernacular schools and a fourth is under construction. They have attracted a sufficient number of students and those that have gone through the course are reported to be doing useful work on their own lands. These schools bear a striking testimony of the development of demonstration work in this Presidency and the example may be followed by other provinces when the activities of the Departments have similarly developed in course of time. In the meantime vernacular courses are being given in some of the Agricultural Colleges, and are quite popular. A proposal is already under consideration to establish a vernacular school in Mysore from the munificent donation of Rs. 25,000 made by a private gentleman.

It will thus be seen that on every side more and more attention is being paid to the practical side of training in agriculture, and there can be little doubt that when this has been properly dealt with, the students passed through the Agricultural Colleges in India will have a more thorough grasp of their subject, besides having learnt thoroughly the value of the maxim "practise what you preach."

Province	No. of superior staff.	*Veterinary Colleges and Schools.*			*Dispensaries and hospitals.*		*District staff and work.*						
		Research.	No. of students at end of year.	No. of subordinate teachers.	No. of dispensaries.	No. of cases treated in hospitals and dispensaries in the year.	No. of Inspectors.	No. of Veterinary Assistants.	No. of outbreaks in which inoculation was undertaken.	Cases treated and castrations performed on tour.	Deaths uninoculated.	Inoculations.	Deaths after inoculation.
Bengal	2+7*	Examination of specimens, etc.	101	6	24	29,349	16	71	342	61,386	3,664	44,481	369
Bihar and Orissa	1	Ditto	..	..	23	26,213	..	66	512	54,904	5,011	98,149	518
United Provinces	2+3†	Kumri; pleuro-pneumonia in sheep and goats; barsati, etc.	..	..	77	84,476	16	89	225	67,718	1,453	18,661	60
Punjab	8+4‡	Examination of specimens; Rabies, Dourine and Surra.	133	..	122	317,982	18	190	388	128,481	3,135	77,017	30
North-West Frontier Province	1	Examination of specimens.	..	..	19	55,932	2	24	100	17,415	469	24,480	5
Bombay	2+2§	Ditto	108	..	53	139,748	5	71	435	43,728	6,696	82,466	449
Central Provinces	2+2†	Ditto	..	..	79	142,231	14	104	300	125,445	2,917	38,481	168
Madras	2+2§	Ditto	65	3	36	29,679	10	91	547	39,145	12,926	91,566	569
Assam	1	Examination of specimens and investigation into Fluke Disease.	..	..	3	4,944	3	39	466	59,976	10,177	49,162	685
Burma	1	Examination of specimens.	63	2	1	1,866	13	150	72	110,721	269	6,814	29
Sind	2+1†	Ditto	..	..	12	15,662	..	13	26	8,570	390	3,016	20
Baluchistan			..	..	5	3,880	..	5	13	5,906	668	1,446	11
Ajmer-Merwara			..	..	2	1,634	..	3	..	368	..	..	..
TOTAL FOR 1915-16	45		470	11	456	853,596	97	916	3,426	723,763	47,775	535,739	2,913
TOTAL FOR 1914-15	59		370	10	424	810,404	105	959	4,229	594,758	48,213	560,600	1,860

* 1 Deputy Superintendent, 1 Assistant Principal and 5 Lecturers.
† Deputy Superintendents.
‡ 1 Deputy Superintendent, 2 Indian Professors and 1 House Surgeon.
§ 1 Deputy Superintendent and 1 Assistant Principal.

CHAPTER V.

Progress in Veterinary Work.

General. The table opposite shows at a glance that the Civil Veterinary Departments can record another year of healthy progress in many directions of their activities. That it does not point to advances in all directions is probably due to the fact that in almost all provinces Veterinary Departments have been handicapped by a shortage of staff. The post of Imperial Bacteriologist at Muktesar remained vacant throughout the year and there was also some depletion of the staff on account of the war. Dr. Norris, the Physiological Chemist attached to the Imperial Bacteriological Laboratory at Muktesar, and three officers of the Indian Civil Veterinary Department—Messrs. P. J. Kerr, A. D. MacGregor and E. S. Farbrother, joined the Indian Army Reserve of Officers and 7 Inspectors and several Veterinary Assistants were deputed to work under the Military Department. Throughout the year Mr. Hewlett, Principal, Bombay Veterinary College, continued to carry out the duties of Embarkation Officer, Bombay, in addition to his civil duties, and the officers of the College and the Glanders and Farcy Department, as well as a number of students of the College, continued to assist the Military Embarkation Officers in dealing with animals found unfit to proceed to their destination. In Baluchistan, Mr. Cattell, Superintendent, Civil Veterinary Department, undertook in addition to his own duties, the control and management of all equine diseases in the Military horse-breeding circle.

As regards the health of all stock, taking India as a whole, the year 1915-16 shows an improvement over 1914-15. Though extensive outbreaks of rinderpest occurred in some of the provinces, especially in Bihar and Orissa, Bombay and Assam, in others there was a considerable abatement in the ravages of the disease and preventive inoculation met generally with marked success. The slight increase in the number of deaths after inoculation appears to be primarily due to the fact that Veterinary Assistants occasionally failed to increase the dose of serum in

accordance with the virulence of the outbreaks and was in no way the fault of the serum. Protective vaccination is probably responsible to some extent for the steady decrease in the death rate under Black Quarter. After a lapse of several years, Dourine reappeared in Dera Ghazi Khan district in the Punjab. Steps are being taken to have the district notified under the Dourine Act (V. of 1910) and to take all other measures that seem possible to prevent the infection spreading to the North-West Frontier Province. It is also interesting to note that a disease in cats prevailed in Berar prior to the occurrence of bubonic plague but unfortunately no specimens for microscopic examination could be secured and a systematic enquiry into the occurrence was not therefore possible. In Baluchistan, dipping baths were used with considerable success in treating scab in sheep and goats. In Burma, severe outbreaks of Foot and Mouth disease occurred during the year.

It is gratifying to note that serum injection, as a preventive measure, is becoming increasingly popular but a majority of the people still refuse to have their cattle inoculated, with the result that outbreaks continue indefinitely, causing large losses to cultivators. In the Central Provinces, the granting of *Sanads* to cultivators and *malguzars* for popularising inoculation has met with success. But, the absence of any measure for compelling cattle owners to have their cattle inoculated, unrestricted movements of infected animals and trade in hides of animals which have died from contagious diseases, jointly tend to militate against efforts to stamp out diseases or guard against re-infection.

Much still remains to be done to improve the existing system of reporting outbreaks and the help of cattle-owners might, to a greater extent, be secured in this direction.

It is satisfactory to note that in Burma villagers are slowly learning to segregate infected animals of their own accord, and it is to be hoped that this practice will extend to other provinces.

Veterinary Education. The opening of a post-graduate course in the Bombay Veterinary College had again to be deferred on account of the employment of many members of the staff on military duties, but a post-graduate course has been started in the Punjab Veterinary College at Lahore. In addi-

tion to the post-graduate course, there are two courses of instruction in this College: (1) the old 3 years' course for military students and students from other provinces, and (2) a 4 years' course for the Punjab and North-West Frontier Province students. Facilities also exist for the training of men in special subjects such as camel diseases, and the advantages of sending back men already in the service for revision courses cannot be too strongly urged. The Bengal Veterinary College held a special class for Sanitary Inspectors deputed by the Sanitary Commissioner, Bengal, in which lectures were delivered on infectious diseases of cattle.

Cattle-Breeding. Satisfactory progress has been made in the cattle-breeding operations in charge of the Department, a notable feature of the year being the establishment of 4 cattle-breeding farms in the Lower Bari Doab Canal Colony in the Punjab. These farms are intended to serve as object lessons in the methods of selection and grading up of herds of Montgomery and Hissar cattle. On the cattle farms at Kheri and Madhurikund (Muttra) in the United Provinces, cross breeding of local varieties with Short-horn and Ayrshire bulls is being conducted with a view to build up a strain which will stand the Indian climate and give a permanently increased milk yield.

Experiments on the grading up of the country sheep, conducted in the United Provinces and in the Punjab, have yielded satisfactory results. The introduction of merinos has considerably improved the wool and mutton of the sheep and the half and the three quarter bred merino-country rams are in great demand.

The Hissar Farm issued during the year 181 bulls and 6 donkey jacks to District Boards in the Punjab and 25 ordnance and transport mules, as well as one donkey stallion, to the Army Remount Department. Two pairs of transport mules were sold to private persons at Rs. 600 per pair. The stallion stable at Bannu was looted on 27th January, 1916, and a number of *syces* and sweepers murdered and one donkey carried off.

Research. In addition to minor investigations mainly connected with the examination of specimens received for diagnosis, the following research work was carried out during the year at the Imperial Bacteriological Laboratory, Muktesar.

Rinderpest. At the request of the Board of Scientific Advice, the observations already in progress on the preservation of rinderpest virus were extended to include a more complete study of the duration of vitality of the virus under natural conditions. The opinions of various authorities differ widely on this point and it is very desirable that definite information should be obtained in relation to the disease in India.

With a view to improving the existing routine method of anti-rinderpest serum manufacture, comparative tests were carried out of the values and yields of sera obtained from bleedings taken at varying intervals after injection of the rinderpest virus. Alterations in respect of the number, volume and times of bleeding after each injection of virus were found to increase both the yield and potency of the serum and were accordingly adopted as routine measures. Comparative tests of different procedures for separating the serum from the blood were also carried out and it was found that a new combined method of centrifuging and clotting gave larger yields of clearer serum than centrifugalization alone; this modification is now applied in the manufacture of all anti-sera. A report by Dr. Norris of the tests as applied to Hæmorrhagic Septicæmia and Anthrax has been published.

Observations were made by Dr. Macalister on the application of serological methods to the determination of the potency of anti-rinderpest serum but so far the results have been negative. The only means of standardization at present available is inoculation of susceptible cattle simultaneously with virulent blood and varying doses of the serum but a more exact and less costly method would be very valuable.

Anthrax and Hæmorrhagic Septicæmia. For both these diseases a means of conferring immunity of longer duration than can be obtained by the use of anti-serum or the present Hæmorrhagic Septicæmia vaccine is urgently required but the necessary condition of perfect safety in application places a serious obstacle in the way of its attainment. Vaccines prepared in various ways from cultures of the organisms have been tested and in certain cases the results have been encouraging. Observations begun by Dr. Macalister on the standardization of the anti-sera of these diseases are still in progress but the investiga-

tion of certain bio-chemical questions in this connection has been interrupted by the temporary transfer of Dr. Norris to Military Service.

Kumri. The investigations into the etiology and pathology of this disease have been continued by Dr. Macalister. A preliminary report on the subject embodying the results obtained up to the present will be published.

Strangles. Certain methods of inoculation have been found more effective and will be tested further. The value of both serum and vaccines in the treatment of the disease and its sequelæ has been frequently demonstrated and these agents are now being largely used in the Army Remount Depôts at Mona and Sargodha.

Contagious abortion. An organism, which produces abortion in pregnant equines and guinea pigs, was isolated. Its further study, particularly in relation to possible means of producing immunity against its action, will be continued.

Surra. With the help of Mr. P. G. Patel, Assistant to the Imperial Pathological Entomologist, a number of interesting experiments on the transmission of surra by biting flies were carried out at the Bareilly Laboratory and an account of these will be published separately. Mr. H. E. Cross, Camel Specialist, recorded his observations on the drug treatment of surra in camels and the course of camel surra in horses, goats and sheep.

Tuberculosis. Cultures of several strains of *B. tuberculosis* were obtained from natural cases of the disease in Indian bovines. The cultural and other characters of the various strains will be studied for the purpose of determining to which variety of the organisms they belong; this point is of importance in relation to both human and bovine tuberculosis in India.

In the Punjab, Mr. Taylor carried out experiments in connection with the anti-rabic inoculation of dogs bitten by rabid dogs, on the same lines as those in use at the Pasteur Institute, Kasauli. Experiments have also been made in the treatment of Dourine. Mr. H. E. Cross, Camel Specialist, carried out further experiments to test the repellent effect on biting flies of various mixtures when applied to the skin of camels and made observations on the susceptibility of camels to Black Quarter and Hæmorrhagic Septicæmia.

In a note on " the possibility of Amoebic Dysentery in the Dog and its Treatment," Mr. F. Ware has described the finding of amœbae in cases of dysentery among the hounds of the Ootacamund pack and the successful results obtained from treatment with Emetin.

Miscellaneous. — The Central Provinces Slaughter of Animals Act of 1915 was passed into law.

A Report on the Dhamri breed of cattle by Mr. D. Meadows and revised editions of the text-book on " Soundness and age " by Colonel H. T. Pease and a hand-book on " Some diseases of cattle in India " by Major G. K. Walker were brought out during the year. Dr. R. V. Norris, Pathological Chemist, published the results of a comparison of the defibrination and oxalate methods of serum preparation as applied to hæmorrhagic septicæmia and anthrax sera together with some analyses of buffalo and hill bull blood. Besides these, various leaflets and bulletins on the question of cattle improvement, protection of live stock against contagious disease, stock feeding, sheep breeding, etc., were issued during the year.

As confidence is established in the methods of prevention or treatment recommended, the public will, it is hoped, avail themselves more and more of the services of the Department. From the Bombay Presidency come two very practical illustrations of appreciation. Seth Chellaram Daloomal of Karachi has very generously contributed Rs. 15,000 towards the cost of establishing a cattle-breeding farm in Sind and another private gentleman has offered to build a new Veterinary Dispensary at Sirsi in the Karwar District. Such actions from a purely voluntary source are a testimony to the good work being done by the Department and its recognition by all interested.

HIND VIEW OF DISC PLOUGH WORKING.

CHAPTER VI.

Publications.

Imperial. The Agricultural Journal of India, Scientific Memoirs and Bulletins continued to be issued during the year. The Department published 13 Memoirs and 6 Bulletins, in addition to the Proceedings of the Inter-Provincial Jute Conference (1915) and of the 9th Meeting of the Board of Agriculture in India (1916). A Bengali version of Bulletin No. 48 on the experiments carried out at Pusa to improve the mulberry silk industry, was also published and copies were distributed gratis in the important silk centres of Bengal. A revised edition of Bulletin No. 39 on instructions for rearing mulberry silk worms and the 2nd Edition of Bulletins Nos. 52 and 53 on 'Soil Ventilation' and 'Soil Erosion and Surface Drainage' respectively, were issued. The Manual of More Deadly Forms of Cattle Disease in India was revised by Major G. K. Walker for the third time and published during the year. It gives a popular description of some of the more important diseases from which cattle suffer in India and their preventive and curative measures and will prove to be a valuable hand-book for stock owners.

The quarterly Agricultural Journal of India continued to maintain its popularity among those who are interested in the agricultural development of this country. The Provincial Departments gave much assistance in contributing valuable articles. A special number of this Journal was issued which included important papers of agricultural interest read at the Third Indian Science Congress held at Lucknow in January, 1916.

Provincial. The Bombay Department of Agriculture issued 5 bulletins and 12 leaflets on various subjects. The Poona College Magazine continued to be issued. Besides, a very interesting report on the committee appointed to consider measures for the improvement of the milk supply in large cities in the Bombay Presidency was made by the Hon'ble Mr. Keatinge who was the President of the Committee. It has been

published at the Government Central Press, Bombay, and is priced annas 3.

Among the publications of the Madras Department, the one deserving special mention is the 'Manual on Elementary Botany' by Rai Bahadur K. Ranga Achariyar, Lecturing Botanist at the Coimbatore College. The manual is intended to meet the requirements of Indian students and is the best work of its kind so far produced. A 2nd edition of Mr. Wood's Note-book of agricultural facts and figures was issued to cope with the demand for it. One bulletin and 8 leaflets were issued, while 73,000 copies of the Annual Agricultural Calendar were published in 5 languages and distributed widely.

The Agricultural and Co-operative Gazette published monthly by the Central Provinces Department of Agriculture continued to be issued. A hand-book of agricultural leaflets was also published.

The most important publication of the United Provinces Department of Agriculture during the year was a bulletin by Mr. Clarke showing the results of the working of the sugarcane research station at Shahjahanpur. Besides, one other bulletin and a report on the Government Experimental Sugar Factory at Nawabganj were published. Several vernacular pamphlets on various subjects and two monthly Journals in vernacular were also issued.

In the Punjab four pamphlets were issued gratis and a Year Book of the Department for 1916 was published.

The Bengal Department issued 3 leaflets in English and vernacular and one vernacular bulletin on potato cultivation. A Year Book of the Department was also issued in Bengali.

The Bihar Department continued to publish the Half-yearly Agricultural Journal for which articles on various subjects were contributed by the College staff at Sabour.

A bulletin on the cultivation of sugarcane and 5 leaflets on the subjects of sugarcane, potatoes and fodder crops were published in the course of the year by the Department of Agriculture, Assam. A leaflet in Bengali dealing with an insect pest of paddy was also issued.

The Burma Department of Agriculture issued two bulletins and two leaflets besides issuing an Agricultural Calendar in Burmese.

Among the Native States, Mysore Department issued one bulletin and three vernacular circulars besides an Agricultural Calendar for 1916. The Travancore Department published a number of popular leaflets in the vernacular and also a bulletin on coffee cultivation. It also publishes a quarterly Journal which is subscribed by 1,200 persons. A similar Magazine in Gujarati is published by the Baroda Department in addition to occasional leaflets on matters pertaining to agriculture.

Besides the departmental publications, the students of the Poona and the Coimbatore Agricultural Colleges issue periodical magazines, the principal object of which is to foster a spirit of *esprit de corps* among the past and present students and to promote the growth of enthusiasm in the agricultural development of the country. All the students who pass through the colleges do not join the Agricultural Department and many are lost in the districts. A scheme of uniting them in one band through the medium of such magazines is therefore of considerable value for the improvement of agriculture. The Poona College Magazine was started in 1909 and the Journal of the Madras Students Union in 1913 and both of these are serving a very useful purpose in bringing the whole of the past and present students into touch with the present day efforts at agricultural development. As the material published in them is intended to relate directly or indirectly to agriculture and consists of actual experiences of the students and of accounts of what is being done by the Agricultural Departments, these magazines are useful not only to students but also to others interested in the improvement of Indian agriculture.

A complete list of the publications issued by the Imperial and Provincial Departments of Agriculture during the year is given as an appendix to this report.

CHAPTER VII.

Expenditure.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year 1915-16 was Rs. 4,63,817, as against Rs. 5,02,648 in the previous year. The details are as follows :—

	Rs.
Office of the Agricultural Adviser to the Government of India and Director of the Institute	2,00,852
Chemical Section	31,699
Mycological Section	32,231
Entomological Section	41,297
Pathological Entomological Section	16,728
Botanical Section	43,803
Bacteriological Section	28,436
Agricultural Section	68,771
TOTAL	4,63,817

In addition to the above a sum of Rs. 23,502 was spent out of the provision of Rs. 23,560 made under "Sugar Experiments" in the budget of this department for 1915-16, in connection with the engagement of Mr. W. Hulme as Sugar Engineer in the United Provinces.

A sum of Rs. 15,000 was paid as a grant-in-aid to the Indian Tea Association.

The principal items of expenditure under the annual grant of Rs. 10,000 placed at the disposal of the Agricultural Adviser to the Government of India for special agricultural experiments were as follows :—

	Rs.
Purchase of a small sugarcane crushing plant required for experiment by the Agricultural Chemist, United Provinces	500
Cost of additional machinery for sugar plant required by Mr. Hulme	6,000
Purchase of silk yarn for sericulture experiments at Pusa	194
Experimental cotton cultivation conducted by the Imperial Cotton Specialist	1,500
Pay of a Veterinary Assistant in connection with cattle breeding and a Fieldman for mosquito experiments	863

The expenditure incurred in the working of the Imperial Bacteriological Laboratory at Muktesar during 1915-16 was as follows :—

	Rs.
Salaries and travelling allowance of officers and establishment	88,166
Feed and keep of animals	89,514
Purchase of animals	19,557
Cost of chemicals and apparatus	11,983
Other miscellaneous expenditure	32,042
TOTAL	2,41,263

The total expenditure which the Provincial Departments of Agriculture incurred during the year under report amounted to Rs. 45,32,844 as against Rs. 46,53,759 during 1915-16. The details are shown below. The decrease is largely due to financial reasons :—

	Rs.
Bengal	6,02,394†
Bihar and Orissa	3,22,855
United Provinces	6,36,072
Punjab	5,89,429§
Bombay	8,31,479‡
Madras	5,46,579
Central Provinces	5,36,589*
Burma	2,13,504§§
Assam	2,03,702
North-West Frontier Province	40,680
Baluchistan	9,561
TOTAL	45,32,844

† Includes Rs. 1,12,878 spent on sericulture.

§ Includes Rs. 1,69,070 spent on buildings.

‡ Includes Rs. 32,427 spent by the Public Works Department on agricultural college and school buildings.

* Includes Rs. 75,243 spent on Botanical and other public gardens.

§§ Includes Rs. 18,850 spent on Botanical and other public gardens.

APPENDIX.

List of Agricultural Publications in India during 1915-16.

No.	Title	Author	Where published
	GENERAL AGRICULTURE.		
1	*The Agricultural Journal of India*, Vol. X, Parts III and IV., and Vol. XI, Parts I and II. Price per Part, Rs. 2 ; annual subscription, Rs. 6 or 8*s.* 6*d.*	Issued from the Agricultural Research Institute, Pusa, Bihar.	Messrs. Thacker, Spink & Co., Calcutta.
2	Special Indian Science Congress number of the *Agricultural Journal of India.* Price Rs. 2 or 3*s.*	Ditto.	Ditto.
3	Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist), for 1914-15. Price As. 8 or 9*d.*	Ditto.	Government Printing, India, Calcutta.
4	Report on the Progress of Agriculture in India for 1914-15. Price As. 5 or 6*d.*	Agricultural Adviser to the Government of India, Pusa.	Ditto.
5	Proceedings of the Inter-Provincial Jute Conference held at Calcutta, from 2nd to 4th August, 1915. Price As. 6 or 7*d.*	....	Ditto.
6	Proceedings of the Board of Agriculture in India, held at Pusa on the 7th February, 1916, and following days (with Appendices). Price Re. 1-2 or 1*s.* 9*d.*	Issued from the Agricultural Research Institute, Pusa.	Ditto.
7	Green-Manuring in India. Bulletin No. 56 of the Agricultural Research Institute, Pusa. Price As. 6 or 7*d.*	A. C. Dobbs, B.A., Imperial Agriculturist.	Ditto.
8	Soil Aeration in Agriculture. Bulletin No. 61 of the Pusa Agricultural Research Institute. Price As. 4 or 5*d.*	A. Howard, C.I.E., M.A., Imperial Economic Botanist.	Ditto.
9	A modified method of Green-Manuring. Bulletin No. 63 of the Pusa Agricultural Research Institute. Price As. 2 or 3*d.*	C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
10	Agriculture in India. Price As. 4.	James Mackenna, M.A., I.C.S.	Government Printing, India, Calcutta.
11	Report of the Committee on Co-operation in India.	....	Government Central Press, Simla.
12	Annual Report of the Board of Scientific Advice for India for the year 1914-15. Price Re. 1 or 1*s.* 6*d.*	Issued by the Board of Scientific Advice for India.	Government Printing, India, Calcutta.
13	Agricultural Statistics of India for 1913-14, Vols. I and II. Price Rs. 2-8 and Re. 1, respectively.	Issued by the Department of Statistics, India, Calcutta.	Ditto.
14	Estimates of area and yield of principal crops in India for 1914-15. Price As. 4.	Ditto.	Ditto.
15	Annual Report of the Department of Agriculture, Bengal, for the year ending 30th June, 1915. Price As. 7.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
16	Annual Report of the Expert Officers (Bengal) for the year ending 30th June, 1915. Price Re. 1-12-0.	Ditto.	Ditto.
17	Potato Cultivation (in Bengali). Bulletin No. 2 of 1915 of the Bengal Department of Agriculture (for free distribution).	Ditto.	Ditto.
18	Season and Crop Report of Bengal for 1915-16. Price Re. 1 or 1*s.* 6*d.*	Ditto.	Ditto.
19	Groundnut.—Leaflet No. 1 of 1916, of the Bengal Department of Agriculture (for free distribution).	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Obtainable from the Department of Agriculture, Bengal.
20	Agricultural Statistics of Bengal for 1914-15. Price As. 12 or 1*s.* 3*d.*	Issued by the Government of Bengal, Revenue Department.	Bengal Secretariat Book Depôt, Calcutta.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
21	Annual Report of the Department of Agriculture, Bihar and Orissa, for 1914-15. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	The Bihar and Orissa Government Press, Patna.
22	Report on the Agricultural Activities of Government in Bihar and Orissa for the year 1914-15. Price Re. 1 or 1*s.* 6*d.*	Ditto.	Ditto.
23	Season and Crop Report, Bihar and Orissa, for 1915-16. Price As. 6 or 6*d.*	Ditto.	Ditto.
24	Leaflet on the use of *Dhaincha.*	Ditto.	Ditto.
25	*Agricultural Journal* (published half yearly), Vol. III, Part II. Subscription Re. 1. per annum.	Ditto.	Ditto.
26	Agricultural Statistics of Bihar and Orissa for 1914-15.	Ditto.	Ditto.
27	Report on the Administration of the Department of Agriculture, United Provinces of Agra and Oudh, for the year ending 30th June, 1915. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
28	Report on the Cawnpore Agricultural Station for the year ending 30th June 1915. Price Re. 1 or 1*s.* 6*d.*	Ditto.	Ditto.
29	Report on the Atarra (Banda) Experimental Station for the year ending 30th June, 1915. Price As. 6 or 6*d.*	Ditto.	Ditto.
30	Report on the Agricultural Station Orai (Jalaun) for the years ending 30th June, 1914 and 1915. Price As. 6 or 6*d.*	Ditto.	Ditto.
31	Report on the Partabgarh Agricultural Station for the year ending 30th June, 1915. Price As. 8 or 9*d.*	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
32	Report on the Agricultural Stations of the Western Circle of the United Provinces for the year ending 30th June, 1915. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
33	Report on the Benares Agricultural Station for the year ending 30th June, 1915. Price As. 6 or 6*d.*	Ditto.	Ditto.
34	Report on the Government Horticultural Gardens, Lucknow, for the year ending 31st March, 1916. Price As. 4 or 6*d.*	Ditto.	Ditto.
35	Report on the Government Botanical Gardens, Saharanpur, for the year ending 31st March, 1916. Price As. 4 or 6*d.*	Ditto.	Ditto.
36	A brochure on School Gardens. Bulletin No. 34 of the Department of Agriculture, United Provinces. Price A. 1 or 1*d.*	H. J. Davies, F.R.H.S., Superintendent, Government Horticultural Gardens, Lucknow.	Ditto.
37	Notes on improved methods of cane cultivation. Bulletin No. 35 of the Department of Agriculture, United Provinces. Price A 1.	G. Clarke, F.I.C., Agricultural Chemist to the Government of the United Provinces.	Ditto.
38	A note on the improvement of the indigenous methods of *Gur* and Sugar making in the United Provinces and a report on the Government Experimental Sugar Factory, Nawabganj, Bareilly District. Price As. 4 or 4*d.*	W. Hulme, Sugar Engineer Expert to the Government of India, and R. P. Sanghi, Sugar Chemist, Experimental Factory.	Ditto.
39	Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1915. Price As. 11 or 1*s.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
40	Year Book of the Punjab Agricultural Department for 1916. Price Re. 1-4.	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
41	Season and Crop Report of the Punjab for the year 1914-15. Price As. 9 or 9*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
42	Catalogue of Ploughs and other Agricultural Implements recommended by the Punjab Agricultural Department (in Urdu), illustrated, 1915—(for free distribution).	Ditto.	Civil and Military Gazette Press, Lahore.
43	Prospectus of the Punjab Agricultural College, Lyallpur (for free distribution).	Ditto.	Government Printing, Punjab, Lahore.
44	Expenses and Profits of cultivators in the Punjab (for free distribution).	Ditto.	Ditto.
45	Cotton Survey Report of the Gujranwalla District (for free distribution).	Ditto.	Ditto.
46	Cotton Survey Report of the Jhang District (for free distribution).	Ditto.	Ditto.
47	Lawrence Gardens' Report. Price A. 1 or 1*d.*	Ditto.	Ditto.
48	Annual Report of the Department of Agriculture, Bombay, for 1914-15. Price As. 12 or 1*s.* 2*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
49	Season and Crop Report of the Bombay Presidency for 1914-15. Price As. 4 or 5*d.*	Ditto.	Ditto.
50	Annual Report of the Sukkur Agricultural Station for 1914-15. Price As. 5-6 or 6*d.*	Ditto.	Ditto.
51	Annual Report of the Surat Agricultural Station for 1914-15. Price Re. 1-10 or 2*s.* 6*d.*	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
52	Annual Report of the Dohad Agricultural Station for 1914-15. Price As. 10-9 or 1*s*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
53	Annual Report of the Dhulia Agricultural Station for 1914-15. Price As. 10-6 or 1*s*.	Ditto.	Ditto.
54	Annual Report of the Jalgaon Agricultural Station for 1914-15. Price As. 9-9 or 11*d*.	Ditto.	Ditto.
55	Annual Report of the Nadiad Agricultural Station for 1914-15. Price As. 13 or 1*s*. 3*d*.	Ditto.	Ditto.
56	Annual Report of the Gokak Canal Agricultural Station for 1914-15. Price As. 11-3 or 1*s*. 1*d*.	Ditto.	Ditto.
57	Annual Report of the Gadag Agricultural Station for 1914-15. Price As. 9-9 or 11*d*.	Ditto.	Ditto.
58	Annual Report of the Dharwar Agricultural Station for 1914-15. Price As. 13-9 or 1*s*. 4*d*.	Ditto.	Ditto.
59	Annual Report of the Alibag Agricultural Station for 1914-15. Price As. 10-6 or 1*s*.	Ditto.	Ditto.
60	Annual Report of the Ratnagiri Agricultural Station for 1914-15. Price As. 9-6 or 11*d*.	Ditto.	Ditto.
61	Annual Report of the Mirpurkhas Agricultural Station for 1914-15. Price As. 5-3 or 6*d*.	Ditto.	Ditto.
62	Annual Report of the Landhi Agricultural Station for 1914-15. Price As. 4-6 or 5*d*.	Ditto.	Ditto.
63	Annual Report of the Larkhana Agricultural Station for 1914-15. Price As. 4-6 or 5*d*.	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
64	Annual Report of the Manjri Agricultural Station for 1914-15. Price As. 14 or 1*s.* 4*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
65	Annual Report of the Experimental plots in Satara and Sholapur Districts for 1914-15. Price As. 1-6 or 2*d.*	Ditto.	Ditto.
66	Annual Report of the Ganeshkhind Botanical Gardens for 1914-15. Price As. 4 or 5*d.*	Ditto.	Ditto.
67	Annual Report of the Agricultural College Dairy, Kirkee, for 1914-15. Price As. 4 or 5*d.*	Ditto.	Ditto.
68	Annual Report of the Poona Agricultural College Farm for 1914-15. Price Re. 1-1 or 1*s.* 7*d.*	Ditto.	Ditto.
69	Annual Report on the Experimental work of the Economic Botanist and his staff for 1914-15. Price As. 2 or 3*d.*	Ditto.	Ditto.
70	Indigenous Implements of the Bombay Presidency. Bulletin No. 66 (1914) of the Department of Agriculture, Bombay. Price Rs. 2-2 or 3*s.*	Rao Saheb G. K. Kelkar, Acting Deputy Director of Agriculture, Bombay Presidency.	Ditto.
71	Fodder crops of Western India. Bulletin No. 77 of the Department of Agriculture, Bombay.	....	Ditto
72	Some wild fodder plants of the Bombay Presidency. Bulletin No. 78 of the Department of Agriculture, Bombay.	....	Ditto.
73	Cultivation of guavas in Gujarat. Bulletin No. 79 of the Department of Agriculture, Bombay.	....	Ditto.
74	List of seeds available on the Agricultural College Farm, Poona. Bulletin No. 80 of the Department of Agriculture Bombay.	....	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author.	Where published
	GENERAL AGRICULTURE—*contd.*		
75	Note on fencing construction. Bulletin No. 81 of the Department of Agriculture, Bombay.	....	Government Central Press, Bombay.
76	Report on the Committee appointed to consider measures for the improvement of the milk supply in large cities in the Bombay Presidency. Price As. 3 or 3*d*.	G. F. Keatinge, C.I.E., I.C.S., President of the Committee.	Ditto.
77	The use of crude night-soil as a manure. Leaflet No. 10 (1915).	Issued by the Department of Agriculture, Bombay.	Ditto.
78	Lucerne—a valuable green fodder. Leaflet No. 11 (1915).	Ditto.	Ditto.
79	Treatment of a mango plantation. Leaflet No. 14 (1915).	Ditto.	Ditto.
80	The improved iron scraper or leveller. Leaflet No. 1 (1916).	Ditto.	Ditto.
81	Poona *Gul* boiling furnace. Leaflet No. 2 (1916).	Ditto.	Ditto.
82	Sulphate of Ammonia as a manure for sugarcane. Leaflet No. 3 (1916).	Ditto.	Ditto.
83	*Rab* substitutes and supplements. Leaflet No. 4 (1916).	Ditto.	Ditto.
84	The I. N. D. and the Monsoon ploughs for North Gujarat. Leaflet No. 5 (1916).	Ditto.	Ditto.
85	Artificial manures for tobacco in the Satara District. Leaflet No. 6 (1916).	Ditto.	Ditto.
86	Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1914-15. Price As. 3 or 3*d*.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
87	Season and Crop Report of the Madras Presidency for 1914-15. Price As. 4 or 6*d*.	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
88	Report of the Work of the Samalkota Agricultural Station for 1914-15. Price As. 2½ or 3*d.*	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
89	Report of the Work of the Coimbatore Agricultural Station for 1914-15. Price As. 2 or 2*d.*	Ditto.	Ditto.
90	Report of the Work of the Hagari Agricultural Station for 1914-15. Price A. 1 or 1*d.*	Ditto.	Ditto.
91	Report of the Work of the Nandyal Agricultural Station for 1914-15. Price A. 1 or 1*d.*	Ditto.	Ditto.
92	Report of the Work of the Taliparamba Agricultural Station for 1914-15. Price A. 1 or 1*d.*	Ditto.	Ditto.
93	Report of the Work of the Manganallur Agricultural Station for 1914-15. Price A. 1 or 1*d.*	Ditto.	Ditto.
94	Report of the Work of the Koilpatti Agricultural Station for 1914-15. Price As. 2 or 2*d.*	Ditto.	Ditto.
95	Report of the Work of the Palur Agricultural Station for 1914-15.	Ditto.	Ditto.
96	Report of the Work of the Anakapalli Agricultural Station for 1914-15. Price A. 1 or 1*d.*	Ditto.	Ditto.
97	Report of the Work of the Sirvel Agricultural Station for 1914-15. Price A. 1 or 1*d.*	Ditto.	Ditto.
98	Madras Agricultural Calender for 1916-17. Price A. 1.	Ditto.	Ditto.
99	Pulichai, Mailam, or Jari cotton in Tinnevelly and Ramnad Districts. Leaflet No. 4 (1915) of the Department of Agriculture, Madras.	D. T. Chadwick, I.C.S., Director of Agriculture, Madras.	Ditto.
100	Water Hyacinth. Leaflet No. 5 (1915) of the Department of Agriculture, Madras.	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
101	List of Agricultural Implements recommended by the Department. Leaflet No. 7 (1915) of the Department of Agriculture, Madras.	D. T. Chadwick, I.C.S., Director of Agriculture, Madras.	Government Press, Madras.
102	Method of Collecting and Dressing *Kolinji* Seed before Sowing. Leaflet No. 8 (1915) of the Department of Agriculture, Madras.	J. Chelvaranga Razu	Ditto.
103	Experience of Kalli Chitti Abhoye Naidu of Pulla, Kistna District, on Green Manure. Leaflet No. 1 of 1916 of the Madras Department of Agriculture.	Chitti Abhoye Naidu	Ditto.
104	Some Uses of Prickly Pear. Leaflet No. 2 of 1916 of the Madras Department of Agriculture.	J. Chelvaranga Razu.	Ditto.
105	Groundnut cultivation in the Upland Taluks of the Godavari District. Leaflet No. 3 of 1916 of the Department of Agriculture, Madras.	D. Balakrishna Murthi.	Ditto.
106	Pulichai, Mailam, or Jari cotton in Tinnevelly and Ramnad Districts. Leaflet No. 4 of 1916 of the Madras Department of Agriculture.	G. A. D. Stuart, I.C.S.	Ditto.
107	Report on the working of the Department of Agriculture, Central Provinces and Berar, for 1914-15. Price Re. 1.	Issue by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
108	Report on the Season and Crops of the Central Provinces and Berar for 1914-15. Price As. 8 or 9*d.*	Department of Land Records, Central Provinces.	Ditto.
109	Report on the Management of the Provincial and District gardens, Central Provinces and Berar, for 1914-15. Price As. 4.	Issued by the Department of Agriculture, Central Provinces.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
110	Report on the Agricultural Stations in Southern Circle, for 1914-15. Price Re. 1.	Issued by the Department of Agriculture, Central Provinces.	Government Press, Central Provinces, Nagpur.
111	Report on Agricultural Stations, Northern Circle. Price Re. 1.	Ditto.	Ditto.
112	Report on Agricultural Stations, Western Circle. Price As. 8.	Ditto.	Ditto.
113	Report on the Experimental Farm, Nagpur, for 1914-15. Price As. 8.	Ditto.	Ditto.
114	Report on Demonstration Work in Southern Circle, for 1914-15. Price As. 8.	Ditto.	Ditto.
115	Report on Demonstration Work in Northern Circle. Price As. 8.	Ditto.	Ditto
116	Report on Demonstration Work in Western Circle, Price As. 8.	Ditto.	Ditto.
117	Report on Agricultural College, Nagpur, Botanical and Chemical Research, Central Museum, Nagpur, and Maharajbagh Menagerie for 1914-15. Price As. 8.	Ditto.	Ditto.
118	Hints on Agricultural economy, Central Provinces and Berar.	Ditto.	Ditto.
119	*The Agricultural and Co-operative Gazette* (monthly) from July 1915 to June 1916. Price As. 2 per issue.	Ditto.	Shalam Press, Nagpur.
120	A Hand-book of Agricultural Leaflets (in Hindi). Price As. 3-6.	G. Evans, M.A., Deputy Director of Agriculture, Northern Circle, Jubbulpur.	George Printing Press, Jubbulpur, Central Provinces.
121	Report on the Operations of the Department of Agriculture, Burma, for the year ending 30th June 1915. Price As. 6 or 7*d.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
122	Season and Crop Report of Burma for the year ending 30th June, 1916. Price, As. 8 or 9*d.*	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
123	Report of the Agricultural Stations of the Southern Circle for the year 1914-15. Price As. 4 or 5*d.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
124	Report of the Mandalay Agricultural Station (including Natywagon Sub-Station) for the year 1914-15. Price As. 6 or 7*d.*	Ditto.	Ditto.
125	Report of the Padu Agricultural Station for the year 1914-15. Price As. 2 or 2*d.*	Ditto.	Ditto.
126	Report of the Buggi Experimental Plot for the year 1914-15. Price As. 2 or 2*d.*	Ditto.	Ditto.
127	Burma Agricultural Calendar for 1916-17 (in Burmese).	Ditto.	Ditto.
128	Minutes of the 8th Half-Yearly Conference of the Agricultural Department held at Maymyo on the 17th and 18th April, 1916.	Ditto.	Ditto.
129	Report of the Third Agricultural and Co-operative Conference, Burma (English and Burmese). Price As. 6.	Ditto.	Ditto.
130	Burmese equivalents for terms connected with Agricultural Science. Occasional Papers No. 2 of the Department of Agriculture, Burma.	Ditto.	Ditto.
131	Note on Formation of Bamboo Plantations. Cultivators' Leaflet No. 45 of the Department of Agriculture, Burma (for free distribution).	Ditto.	Ditto.
132	Sugarcane Cultivation. Cultivators' Leaflet No. 46 of the Burma Department of Agriculture.	A. Mackerral, M.A., B.SC., Deputy Director of Agriculture, Southern Circle, Burma.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
133	Report of the Department of Agriculture, Assam, for the year ending 30th June, 1915. Price As. 8 or 9*d.*	Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
134	Report on the Season and Crops of Assam for 1915-16. Price As. 8 or 9*d.*	Ditto.	Ditto.
135	Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June, 1915.	Ditto.	Ditto.
136	Annual Report of the Kamrup Sugarcane Experiment Station for the year ending 30th June, 1915.	Ditto.	Ditto.
137	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June, 1915.	Ditto.	Ditto.
138	Annual Report of the Karimganj Agricultural Experiment Station for the year ending 30th June, 1915.	Ditto.	Ditto.
139	Annual Report of the Agricultural Experiments and Demonstrations in Assam for the year ending 30th June, 1915.	Ditto.	Ditto.
140	Annual Report of the Fruit Experiment Station, Shillong, for the year ending 30th June, 1915.	Ditto.	Ditto.
141	The Cultivation of Sugarcane (in English, Bengali, and Assamese). Bulletin No. 1 (1915) of the Department of Agriculture, Assam.	Ditto.	Ditto
142	Iron Sugarcane Mills (in English, Bengali, and Assamese). Leaflet No. 2 (1915) of the Department of Agriculture, Assam.	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
143	Some better varieties of Sugarcane for the Assam Valley (in English, Bengali, and Assamese). Leaflet No. 3 (1915) of the Department of Agriculture, Assam.	Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
144	Potato Cultivation in the plains (in English, Bengali, and Assamese). Leaflet No. 4 (1915) of the Department of Agriculture, Assam.	Ditto.	Ditto.
145	Fodder Crops (in English, Bengali, and Assamese). Leaflet No. 5 (1915) of the Department of Agriculture, Assam.	Ditto.	Ditto.
146	Annual Report of the Peshawar Agricultural Station at Tarnab in the North-West Frontier Province for the year ending 30th June, 1915.	Issued by the Department of Agriculture, North-West Frontier Province.	Messrs. Thacker, Spink & Co., Calcutta.
147	Some improvements in the packing and transport of fruit in India. Bulletin No. 2 of the Fruit Experiment Station, Quetta.	A. Howard C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist.	Baptist Mission Press, Calcutta.
148	Soil ventilation. Bulletin No. 3 of the Fruit Experiment Station, Quetta.	Ditto.	Ditto.
149	The saving of irrigation water in wheat growing. Bulletin No. 4 of the Fruit Experiment Station, Quetta.	Ditto.	Ditto.
150	Clover and Clover Hay. Bulletin No. 5 of the Fruit Experiment Station, Quetta.	Ditto.	Ditto.
151	Annual Report of the Department of Agriculture, Mysore, 1914-15.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*contd.*		
152	Mysore Agricultural Calendar, 1916. Price 1 anna.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
153	Report on the Working of the Government Gardens and Parks in Mysore for 1914-15.	Ditto.	Ditto.
154	A Note on the milk supply of Bangalore. Bulletin No. 7.	Ditto.	Ditto.
155	Report on the Operations of the Department of Agriculture and Fisheries, Travancore, for 1914-15.	Issued by the Department of Agriculture, Travancore.	Government Press, Trivandrum.
156	Coffee Cultivation. A bulletin on—.	Ditto.	Ditto.
157	*Quarterly Agricultural Journal* (in vernacular).	Ditto.	Ditto.
158	The *Journal of the Madras Agricultural Students' Union* (monthly). Annual subscription Re. 1.	Madras Agricultural Students' Union.	Literary Sun Press, Coimbatore.
159	Report on the Production of Tea in India. Price, As. 8.	Department of Statistics, India.	Government Printing, India, Calcutta.
160	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Press, Calcutta.
161	Experiments with phosphatic manures on green crops.	Ditto.	Ditto.
162	The *Planters' Chronicle* (weekly). Price As. 8.	United Planters' Association of South India.	Daily Post Press, Bangalore.
163	The *Journal of Dairying and Dairy Farming in India.* (Issued quarterly.)	Published by the Indian Committee of the Dairy Education Association.	Messrs. Thacker, Spink & Co., Calcutta.
164	The Milk Problem in Indian Cities. Price Rs. 5.	Lemuel L. Joshi, B.SC., M.D., Municipal Analyst, Bombay.	D. Taraporevala Sons & Co., Bombay.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	GENERAL AGRICULTURE—*concld.*		
165	Dairying and Dairy breeds (in Marathi). Price Re. 1.	B. K. Ghare, L.Ag., Lecturer, Agricultural College, Cawnpore.	Vaidic Patrika Press.
166	The *Indian Journal of Economics* (Quarterly), Vol. I, Parts I and II. Annual subscription, Rs. 12.	University of Allahabad.	Pioneer Press, Allahabad.
167	*Bengal Economic Journal* (Quarterly), Vol. I, No. 1. Annual subscription, Rs. 10.	Bengal Economic Association.	Central Publishing Co., Calcutta.
168	*Mysore Economic Journal* (monthly). Annual subscription, Rs. 4.	Mysore Economic Conference.	Vokkaligara Press, Bangalore.
169	*Bengal Co-operative Journal* (bi-monthly). Annual subscription, Rs. 2-8.	Gupta, Mukherjee & Co.	Art Press, Calcutta.
170	The *Indian Agriculturist* (monthly). Annual subscription, Rs. 12.	R. Knight & Sons .	The 'Statesman' Printing Press, Calcutta.
171	*Indian Poultry Gazette* (monthly). Subscription Rs. 3 per annum.	Indian Poultry Club, Lucknow.	Mafasilite Electric Printing Works, Mussoorie.
	AGRICULTURAL CHEMISTRY.		
172	Soil Temperatures. Memoirs of Department of Agriculture in India, Chemical Series, Vol. IV, No. 2. Price Rs. 2 or 3*s.*	J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist.	Messrs. Thacker, Spink & Co., Calcutta.
173	Soil Gases. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 3. Price Re. 1-8-0 or 2*s.* 6*d.*	Ditto.	Ditto.
174	The Gases of Swamp Rice Soils, Part III. A Hydrogen-oxidizing Bacterium from these Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 4. Price As. 12 or 1*s.*	W. H. Harrison, M.Sc., Government Agricultural Chemist, Madras, and P. A. Subramania Aiyer, B.A., Assistant to the Government Agricultural Chemist.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY —*contd.*		
175	Some Factors affecting the cooking of Dholl (*Cajanus indicus*). Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 5. Price Re. 1 or 1*s.* 6*d.*	B. Viswanath, T. Lakshman Row, B.A., and P. A. Raghunathaswami Ayyangar, D.A., Assistants to the Government Agricultural Chemist, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
176	The Insects attacking stored wheat in the Punjab and the methods of combating them (including a chapter on the Chemistry of Respiration). Memoirs of the Department of Agriculture in India), Chemical Series, Vol. IV, No. 6. Price Rs. 3-8-0 or 5*s.* 6*d.*	J. H. Barnes, B.SC., F.I.C., Agricultural Chemist, Punjab; and A. J. Grove, M.SC., Supernumerary Entomologist, Pusa.	Ditto.
177	Studies in the Chemistry and Physiology of the leaves of the Betel Vine (*Piper betle*) and of the Commercial bleaching of betel-vine leaves. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 7. Price Re. 1 or 1*s.* 6*d.*	Harold H. Mann, D.SC., Agricultural Chemist, to the Government of Bombay, and V. G. Patwardhan, B.AG.	Ditto.
178	The Detection of Added Water in Milk in India. Bulletin No. 57 of the Agricultural Research Institute, Pusa. Price As. 2 or 3*d.*	J. W. Leather, V.D., F.I.C., Imperial Agricultural Chemist.	Government Printing, India, Calcutta.
179	A preliminary Chemical study of the Rices of Bihar and Orissa. Bulletin No. 62 of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d.*	J. N. Sen, M.A., officiating Imperial Agricultural Chemist.	Ditto.
180	A study in the Assimilation of Nutrients by the Rice Plant. Bulletin No. 65 of the Agricultural Research Institute, Pusa. Price As. 2 or 3*d.*	Ditto.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	AGRICULTURAL CHEMISTRY —*concld.*		
181	Note on the Soil of the Experimental Farms. Bulletin No. 13 of 1916 of the Department of Agriculture, Burma. Price As. 2 or 2*d.*	F. J. Warth, M.Sc., Agricultural Chemist, Burma.	Government Printing, Burma, Rangoon.
182	A Soil Survey of the Guntur Delta. Bulletin No. 70 of the Department of Agriculture, Madras. Price Re. 1-8 or 2*s.* 3*d.*	W. H. Harrison, M.Sc., and B. Vishwanath.	Government Press, Madras.
	BOTANY.		
183	Experiments on the Physiology of Indigo-yielding Glucosides. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 5. Price Re. 1 or 1*s.* 6*d.*	F. R. Parnell, B.A., Government Botanist, Madras.	Messrs. Thacker, Spink & Co. Calcutta.
184	Some Varieties of Indian Gram (*Cicer arietinum*, L.). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 6. Price Re. 1 or 1*s.* 6*d.*	Albert Howard, C.I.E., M.A., Gabrielle L. C. Howard, M.A.; and Abdur Rahman Khan, Second Assistant to the Imperial Economic Botanist.	Ditto.
185	Studies in Indian Oil seeds No. 1, Safflower and Mustard. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 7. Price Re. 1-8 or 2*s.* 6*d.*	Ditto.	Ditto.
186	On the Inheritance of Some Characters in Wheat—II. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 8. Price Re. 1-8-0 or 2*s.* 6*d.*	A. Howard, C.I.E., M.A., Imperial Economic Botanist and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist.	Ditto.
187	The Wheats of Baluchistan, Khorasan and the Kurram Valley. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VIII, No. 1, Price Re. 1-12-0 or 2*s.* 6*d.*	Grabrielle L. C. Howard, M.A., 2nd Imperial Economic Botanist.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	BOTANY—*concld.*		
188	Studies in Indian Sugarcanes, No. 2. Sugarcane Seedlings, including some correlations between Morphological Characters and Sucrose in the Juice. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VIII, No. 3. Price Re. 3 or 4*s.* 3*d.*	C. A. Barber, Sc.D. (Cantab.), Government Sugarcane Expert, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
189	A manual of Elementary Botany for India. Price Rs. 2 or 3*s.*	Rai Bahadur K. Ranga Achari, M.A., L.T., Lecturing Botanist, Agricultural College, Coimbatore.	Government Press, Madras.
190	An Account of the Genus *Capsicum* grown in the Central Provinces and Berar. Bulletin No. 5 of the Central Provinces Department of Agriculture (only 50 copies available for sale).	K. P. Shrivastava, Assistant Economic Botanist, Central Provinces.	Government Press, Central Provinces, Nagpur.
191	Methods of Testing Seeds. Leaflet No. 3 of 1915 of the Bengal Department of Agriculture.	G. P. Hector, M.A., B.Sc., Economic Botanist, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
	MYCOLOGY.		
192	The Genus *Rhizoctonia* in India. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 4. Price Re. 1 or 1*s.* 6*d.*	F. J. F. Shaw, B.Sc. and S. L. Ajrekar, B.A.	Messrs. Thacker, Spink & Co., Calcutta.
193	Compressed Air Sprayer for Spraying Arecanuts. Leaflet No. 6 (1915) of the Madras Department of Agriculture.	W. McRae, M.A., B.Sc., Government Mycologist, Madras.	Government Press, Madras.
194	Black Thread Disease of *Hevea* in Burma. Bulletin No. 14 of 1916 of the Burma Department of Agriculture. Price As. 2 or 2*d.*	J. F. Dastur, B.Sc., 1st Assistant to the Imperial Mycologist, Pusa.	Government Printing, Burma, Rangoon.

List of Agricultural Publications in India during 1915-16—contd.

No	Title	Author	Where published
	MYCOLOGY—*concld.*		
195	Tea Roots, Pt. 1 . . .	A. C. Tunstall, B.Sc.; Mycologist to the Indian Tea Association.	Catholic Orphan Press, Calcutta.
196	Lucerne dodder. Leaflet No. 12 (1915) of the Department of Agriculture, Bombay.	....	Government Central Press, Bombay.
197	Smut on *Jowari* or *rala*. Leaflet No. 13 of the Department of Agriculture, Bombay.	....	Ditto.
	ENTOMOLOGY.		
198	*Calocoris angustatus*, Leth. Bulletin No. 58 of the Agricultural Research Institute, Pusa. Price As. 4 or 5*d*.	E. Ballard, B.A., F.E.S., Government Entomologist, Madras.	Government Printing, India, Calcutta.
199	One Hundred Notes on Indian Insects. Bulletin No. 59 of the Agricultural Research Institute, Pusa. Price As. 8 or 9*d*.	T. Bainbrigge Fletcher, F.L.S., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
200	First Report on the Experiments carried out at Pusa to improve the Mulberry Silk Industry, compiled under the direction of the Imperial Entomologist. Bulletin No. 48 of the Agricultural Research Institute, Pusa. Price As. 6 or 7*d*. (Translated into Bengali.)	M. N. De, Sericulture Assistant, Pusa.	Ditto.
201	Instructions for rearing Mulberry Silk worms. Bulletin No. 39 of the Agricultural Research Institute, Pusa (Revised edition). Price As. 8 or 9*d*.	Ditto.	Ditto.
202	The Mango Shoot-borer. Leaflet No. 2 of 1916 of the Bengal Department of Agriculture (for free distribution).	P. C. Sen, Entomological Collector, Bengal.	Obtainable from the Department of Agriculture, Bengal.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	ENTOMOLOGY—*concld.*		
203	Bees and the Fertillization of Coffee. Bulletin No. 69 of the Department of Agriculture, Madras. Price As. 3.	T. Bainbrigge Fletcher, F.L.S., F.E.S., F.Z.S., Imperial Entomologist.	Government Press, Madras.
204	Report on Investigations regarding the *Maho* (*Nephotettix bipunctatus* and *N. apicalis*) in the Central Provinces.	C. S. Misra, 1st Assistant to Imperial Entomologist.	....
205	The Palm beetles. Leaflet No. 9 (1915) of the Department of Agriculture, Bombay.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
206	*Kumblihulas* attacking crops in Mysore. Circular No. 15 of the Department of Agriculture, Mysore.	Issued by the Department of Agriculture, Mysore.	....
207	*Kondlihula* of castor. Circular No. 16 of the Department of Agriculture, Mysore.	Ditto.	....
208	*Kokkreroga* of paddy. Circular No. 17 of the Department of Agriculture, Mysore.	Ditto.	....
	AGRICULTURAL BACTERIOLOGY.		
209	Azotobacter and Nitrogen Fixation in Indian Soils. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. I, No. 4. Price Re. 1 or 1*s.* 6*d.*	J. H. Walton, B.A., B.Sc., Supernumerary Agricultural Bacteriologist.	Messrs. Thacker, Spink & Co., Calcutta.
210	Bacterial Rot of Stored Potato Tubers. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. I, No. 5. Price Re. 1 or 1*s.* 6*d.*	C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist, and N. V. Joshi, B.A., B.Sc., L.Ag., 1st Assistant to the Imperial Agricultural Bacteriologist.	Ditto.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	AGRICULTURAL BACTERIOLOGY—*concld.*		
211	*Bakhar*—The Indian Rice Beer Ferment. Memoirs of the Department of Agriculture in India, Bacteriological Series, Vol. I, No. 6. Price Re. 1 or 1*s.* 6*d.*	C. M. Hutchinson, B.A., Imperial Agricultural Bacteriologist, and C. S. Ram Ayyar, B.A., Assistant to the Imperial Agricultural Bacteriologist.	Messrs. Thacker, Spink & Co., Calcutta.
	VETERINARY.		
212	Annual Report of the Imperial Bacteriologist, Muktesar Laboratories, for the year 1914-15. Price As. 3 or 4*d.*	Issued by the Agritural Adviser to the Government of India, Pusa.	Government Printing, India, Calcutta.
213	A comparison of the "Defibrination" and "Oxalate" methods of serum preparation as applied to Hæmorrhagic Septicæmia and Anthrax Sera together with some analyses of buffalo and hill bull blood. Bulletin No. 60 of the Agricultural Research Institute, Pusa. Price As. 3 or 4*d.*	R. V. Norris, M.Sc., D.Sc., F.I.C., Physiological Chemist, Muktesar Laboratories.	Ditto.
214	Rinderpest Preparation of Antiserum. Bulletin No. 64 of the Agricultural Research Institute, Pusa. Price As. 3 or 4*d.*	A. W. Shilston, M.R.C.V.S., Officiating Imperial Bacteriologist, Muktesar.	Ditto.
215	Statistics compiled by the Government of India from the Reports of Provincial Civil Veterinary Departments for 1914-15.	Issued by the Government of India, Revenue and Agriculture Department.	Ditto.
216	Some Diseases of Cattle in India, 1916. A handbook for stock owners. Price As. 8 or 9*d.*	Major G. K. Walker, C.I.E., Superintendent, Civil Veterinary Department, Bombay.	Ditto.
217	Report of the Civil Veterinary Department, Bengal, for the year 1914-15.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.

List of Agricultural Publications in India during 1915-16—contd.

No.	Title	Author	Where published
	VETERINARY.		
218	Annual Report of the Civil Veterinary Department, Bihar and Orissa for 1915-16.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
219	Leaflet on Hæmorrhagic Septicæmia.	Issued by the Civil Veterinary Department, Bihar and Orissa.	....
220	Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1916.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
221	A preliminary Note on Sheep breeding Experiments.	Civil Veterinary Department, United Provinces.	Anglo-Oriental Press, Lucknow.
222	Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1914-15. Price Re. 1-2 or 1*s.* 9*d.*	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
223	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1915-16. Price Re. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
224	Annual Report of the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for the year 1914-15. Price As. 4 or 4*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
225	Annual Report of the Camel Specialist for the year 1914-15. Price As. 2 or 2*d.*	Ditto.	Ditto.
226	Administration Report of the Bombay Veterinary College and Civil Veterinary Department in the Bombay Presidency including Sind, for 1914-15. Price As. 7 or 8*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1915-16—concld.

No.	Title	Author	Where published
	VETERINARY—*concld.*		
227	Report of the Civil Veterinary Department, Burma, for the year ending 31st March 1916. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Burma.	Government Press, Rangoon.
228	Report of the Civil Veterinary Department, Assam, for 1914-15. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Secretariat Press, Shillong.
229	Annual Report of the Government Stud Farm at Kunigal, Mysore, for 1914-15.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.

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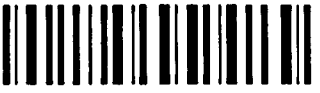
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